AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
J	1 | 66

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO.(If applicable)
0004	19-May-2004	W68SBV-3338-9201	

6. ISSUED BY	CODE	7. ADMINISTERED BY (If other than item 6)	CODE
WALLA WALLA DISTRICT, COE-G4P CONTRACTING DIVISION 201 N THIRD AVENUE WALLA WALLA WA 99362-1876	W912EF	WALLA WALLA DISTRICT, COE-G4P PATTI RECORD 509/527-7224 PATTI.C.RECORD@USACE.ARMY.MIL WALLA WALLA WA	W912EF

8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)		
	X	9A. AMENDMENT OF SOLICITATION NO. W912EF-04-R-0009
	X	9B. DATED (SEE ITEM 11) 19-Mar-2004
		10A. MOD. OF CONTRACT/ORDER NO.
		10B. DATED (SEE ITEM 13)
CODE / FACILITY CODE		

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer [X] is extended, [ ] is not extended.

Offer must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods: (a) By completing Items 8 and 15, and returning _____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS.
IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

[ ] A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

[ ] B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(B).

[ ] C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

[ ] D. OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor [ ] is not, [ ] is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

SUPPLY: Digital Exciters for Lower Monumental Dam (Units 1-3), and Lower Granite Dam (Units 1-3), Franklin and Garfield Counties, Washington.

Bid opening date is being extended to June 3, 2004 2:00pm.

See Summary of Changes for description of changes to the original solicitation.dated March 19, 2004.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print) TEL: EMAIL:	
15B. CONTRACTOR/OFFEROR _____ (Signature of person authorized to sign)	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY _____ (Signature of Contracting Officer)	16C. DATE SIGNED 19-May-2004

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

SUMMARY OF CHANGES

SECTION B - SUPPLIES OR SERVICES AND PRICES

1. **BID OPENING DATE HAS BEEN EXTENDED TO THURSDAY, JUNE 3, 2004 4:00 PM.**

2. Delete and Replace Section H Special Contract Requirements -252.236-7001 Contract Drawings, Maps and Specifications with the attached Revised Section H, 252.236-7001 Contract Drawings, Maps and Specifications.

3. Delete and Replace Technical Specifications - Section 16251 with attached revised copy. Noting Revised paragraphs 2.4.4.4 and 3.6.2.4. Included a new saturation curve for Lower Monumental Dam.

4. Added 2 new drawings.

5. Revised two existing drawings

INSTRUCTIONS: The offeror must acknowledge receipt of this amendment by documenting the amendment number and date in Block 14 of Standard Form 33, "Solicitation, Offer and Award."

SECTION 16251

LGLMEX0316251

EXCITATION SYSTEM

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SECTION 16251

EXCITATION SYSTEM

PART 1 GENERAL

1.1 GENERAL INFORMATION

1.1.1 Scope of Work

This section covers the work necessary to design, to prepare drawings, data, installation instructions, to manufacture, to shop test, to prepare and load for shipment, and to deliver f.o.b. destination, and to install, make completely operational, and field test three complete digital excitation systems, three Power System Stabilizers, and three Power Potential Transformers for the Lower Monumental Powerhouse Units 1-3 and three complete digital excitation systems, three Power System Stabilizers, and three Power Potential Transformers for the Lower Granite Powerhouse Units 1-3. The work also includes the following items:

a. Removing the existing six excitation systems' non-rotating parts for these units.

b. Removing existing excitation power, signal, and control cabling and providing new power, signal, and control cabling for the new exciters.

c. Providing molded case circuit breakers and the required cabling for exciter field flashing.

d. Providing training for Lower Monumental and Lower Granite Project personnel on the operation and maintenance of the new exciters.

1.1.2 Description of Generators

The exciters shall supply excitation to the existing hydro generators.

The generators at Lower Monumental Project are 3-phase, 60 Hz, 13.8 KV, salient pole, vertical synchronous generators with 115 percent continuous overload capacity, manufactured by the General Electric Corporation. Units 1 - 3 were placed into service in 1968 and have direct connected vertical shaft shunt wound DC generators with amplidyne motor generator controls.

The generators at Lower Granite Project are 3 - phase, 60 Hz, 13.8 KV, salient pole, vertical synchronous generators with 115 percent continuous overload capability, manufactured by the Westinghouse Electric Corporation. Units 1 - 3 were placed into service in 1975 and 1976 and they have a direct connected vertical shaft, shunt-wound, direct current generator in conjunction with a WTA designed regulator.

The generator ratings, as defined by their nameplates, are as follows:

	Lower Monumental Units 1-3	Lower Granite Units 1-3
Rating (kVA)	142,105	142,105
Power Factor (%)	95	95
Rating (kW)	135,000	135,000
Speed (r/min)	90	90
Temperature Rise (°C)	59	60
Rated Excitation Current, nameplate	1333	1088
Rated Excitation Voltage, nameplate	375	375
Generator Synchronous Reactance (p.u)	0.91	0.975

1.1.3 Generator Characteristic Data

Copies of the existing generator field saturation test curves are included in these specifications at the end of this section. Other pertinent generator characteristics are:

	Lower Monumental Units 1-3	Lower Granite Units 1-3
Field current (A)		
Rated load 1.0 pf (acceptance test)	828	789
Rated load, rated pf (acceptance test)	1023	941
115 % rated load, rated pf (acceptance test)	1132	1020
115% rated load, 1.0 pf (acceptance test)	895	852
Field Resistance at 75 °C (Ohms)	0.2487	0.2426
Field Winding Temperature, (by Resistance), rated load (°C)	59.5	79.4

1.1.4 Asbestos

1.1.4.1 The control wiring at Lower Monumental and Lower Granite may contain asbestos. The wiring at Lower Monumental that may contain asbestos is the wire used on the field reostat resister bank. The Contractor shall test cable insulation at both powerplants to determine if the wire contains asbestos. If the insulation contains asbestos then the Contractor shall handle, contain, and dispose of the wire in accordance with Federal and state laws and regulations. Workers shall wear appropriate safety equipment such as gloves, long sleeve shirts, half mask respirators with HEPA filters, goggles. Wiring shall be double bagged, labeled, and disposed of in a landfill licensed to receive asbestos materials in accordance with law. The Contractor shall submit a copy of the documentation from the landfill to the Government after disposal. All cables that are replaced shall be removed completely.

1.1.4.2 The arc chutes in the existing field breakers and transfer relays (device 83) at Lower Monumental and the arch chutes in the existing field breakers at Lower Granite may contain asbestos. The interior of the breaker cabinets may contain dust from opening and closing of the breakers. Dust shall be tested for asbestos. If dust contains asbestos remove the dust with HEPA filtered vacuum, wet wipes, or other method allowed by law. The Contractor shall handle, contain, transport, and dispose of the asbestos containing materials in accordance with Federal and state laws and regulations. Arc chutes that contain asbestos shall be removed from the breakers and the arc chutes and all other asbestos materials shall be disposed of in a landfill licensed to receive asbestos materials. The Contractor shall submit a copy of the documentation from the landfill to the Government after disposal. Workers shall wear appropriate safety equipment as described in paragraph 1.1.4.1.

1.1.5 Lead Based Paint

Existing cubicles may be coated with Lead Based Paint. Contractor shall conform to the requirements in Section 02090 if work requires disturbing the paint.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

ANSI C34.2 (1973) Semiconductor Power Rectifiers (Withdrawn)

Note: The requirements of ANSI C34.2 are part of this specification even though the standard is no longer in publication. The Contractor shall obtain a historical copy of the standard for use.

ANSI C39.1 (R 1992) Electrical Analog Indicating Instruments

ANSI C50.10 (1990) Rotating Electric Machinery Synchronous Machines

ANSI C50.12 (1989) Salient-Pole Synchronous Generators and Generator/Motors for Hydraulic Turbine Applications

ANSI B1.20.1 (2001) Pipe Threads, General Purpose (inch)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 8 (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium, or Soft

ASTM B 187 (2001) Copper Bus Bars, Rod, and Shapes

ASTM B 188 (2002) Seamless Copper Bus Pipe and Tube

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1 (2001) Unified Inch Screw Threads (UN and UNR Thread Form)

CODE OF FEDERAL REGULATIONS (CFR)

CFR 29 Part 1910 (2002) Occupational Safety and Health Administration, Labor

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.20.1 (2002) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear

IEEE C37.20.2 (1999) Metal-Clad and Station-Type Cubicle Switchgear

IEEE C37.90 (1994) Relays and Relay Systems Associated with Electric Power Apparatus

IEEE C37.90.1 (2002) Surge Withstanding Capability (SWC) Tests for Protective Relays and Relay Systems

IEEE C57.12.01 (1998) Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings

IEEE C57.12.91 (2001) Test Code for Dry-Type Distribution and Power Transformers

IEEE C57.110 (1998) Recommended Practice for Establishing Transformer Capability When Supplying Non-sinusoidal Load Currents

IEEE 115 (2002) IEEE Guide: Test Procedures for Synchronous Machines

IEEE 383 (1992) Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations (Reapproved 1992)

IEEE 421.1 (1996) Definitions for Excitation Systems for Synchronous Machines

IEEE 421.2 (1990) Guide for Identification, Testing, and Evaluation of the Dynamic Performance of Excitation Control Systems

IEEE 421.3 (1997) Standard for High-Potential Test Requirements for Excitation Systems for Synchronous Machines

IEEE 421.5 (1992) Recommended Practice for Excitation System Models for Power System Studies

IEEE 1110 (1991) Guide for Synchronous Generator Modeling Practices in Stability Analyses

THE INSTRUMENTATION, SYSTEMS, & AUTOMATION SOCIETY (IAS)

ISA 18.1 (1979) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1992) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA AB 1 (2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

NEMA AB 3 (2001) Molded Case Circuit Breakers and Their Application

NEMA SG 3 (1995) Low-Voltage Power Circuit Breakers

NEMA WC 57 (1998) Control Cables

NEMA WC 70 (2001) Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code, 2002 Edition

UNDERWRITERS LABORATORIES INC. (UL)

UL 44 (2002) Thermoset-Insulated Wires and Cables

UL 489 (2003) Molded Case Circuit Breakers and Circuit Breaker Enclosures

1.3 SUBMITTALS

Government approval is required for all submittals with a “GA” designation; submittals having an “FIO” designation are for information only. The following shall be submitted in accordance with SECTION 01330.

1.3.1 SD-01 Data

Within 90 calendar days after date of receipt of signed contract:

1.3.1.1 Names Of Equipment Manufacturers And Performance Capacities; GA

Submit for all equipment to be incorporated into the excitation system.

1.3.1.2 Nameplate Schedule, Including Sizes And Lettering; GA

1.3.1.3 Parts List; GA

The list shall include all parts to be included in the excitation systems, with each part numbered and cross-referenced to the drawings. Each part shall be identified by name, manufacturer, and rating (ohms, farads, etc., as appropriate).

Within 120 calendar days after date of receipt of notice of award:

1.3.1.4. Spare Parts List: GA

The list shall include all spare parts to be furnished under this contract, with each part numbered and cross-referenced to the drawings and parts list. Each part shall be identified by name, manufacturer, rating (ohms, farads, etc., as appropriate) and quantity furnished. All proprietary or house-marked items (such as transformers, inductors, integrated circuits, or printed circuits) shall be identified along with their source. Printed circuit cards that require depot- or factory-level maintenance or that are uneconomical or too complicated to repair shall also be identified.

1.3.1.5 Draft Of Excitation Equipment Mathematical Models and Data; GA

Submit for use in transient stability and longer-term dynamics simulation programs.

The models and data shall be consistent with IEEE 421.5 and the following IEEE committee papers. Models and data are required for control functions including limiters, but not for protective functions that operate for excitation equipment failures. The models shall include minimum, maximum, and typical values for all gains, time constants, and limiters. If equipment supplied is not compatible with IEEE models, special models must be provided with enough detail for unambiguous programming in simulation programs.

a. IEEE Digital Excitation Task Force, “Computer Models for Representation of Digital-Based Excitation Systems,” IEEE/PES paper 96 WM 031-5 EC.

b. IEEE Excitation Limiters Task Force, “Recommended Models for Over-excitation Limiting Devices,” IEEE Transactions on Energy Conversion, Vol. 10, No. 4, pp. 706-712, December 1995.

c. IEEE Excitation Limiters Task Force, “Under-excitation Limiter Models for Power System Stability Studies, “ IEEE Transactions on Energy Conversion, Vol. 10, No. 3, pp. 524-531, September 1995.

1.3.2 SD-04 Drawings

Within 60 calendar days after date of receipt of signed contract:

1.3.2.1 Outline Drawings; GA

Including final weight and overall dimensions.

1.3.2.2 Arrangement Drawings; GA

Including power potential transformer.

1.3.2.3 Overall One Line Diagram; GA

1.3.2.4 Schematic Diagrams; GA

1.3.2.5 Wiring Diagrams; GA

Excitation equipment wiring diagrams shall be made as seen by an observer of the actual equipment arrangement, and space shall be provided for addition of devices where mounting space exists on the structure. Information on out going cable circuits will be provided by the Government after award of the contract. The drawings shall provide a space at least 3 inches below and adjacent to terminal blocks in which external cable circuits, conduits, and connections may be shown. The Contractor shall add them to the drawings within 30 calendar days after being furnished by the Government.

1.3.2.6 Bus Connection Between Power Potential Transformer And Excitation Cubicle; GA

1.3.2.7 Generator Bus Tap Design; GA

Including the routing of the conduit.

1.3.2.8 The design for the dc circuit from the exciter to the slip rings; GA

1.3.2.9 Equipment Installation Drawings; GA

Equipment installation drawings, including materials list and cable and conduit schedule.

Within 120 calendar days after date of receipt of signed contract:

1.3.2.10 Circuit Card Schematics; GA.

1.3.2.11 Other Drawings; GA

Additional drawings as required demonstrating that all parts of the equipment being furnished conform to the requirements of the specifications.

Within 30 days after completion and final acceptance of installation:

1.3.2.12 Installation drawings showing as built changes; GA.

1.3.3 SD-07 Schedules and Plans

1.3.3.1 Installation Plan and Schedule; GA

The plan and schedule shall not duplicate information in the installation procedure but shall refer to those procedures with specific information on the manner in which work will be prosecuted on site. The plan shall contain a step-by-step activity listing and a schedule, which demonstrates the dependency of one activity on another. Included in the plan and schedule shall be the number of shifts to be worked and hours per shift, crew sizes, and persons on each shift responsible for superintendency and safe clearance. Activities that

are hazardous, affect plant operation, or require participation by Government personnel shall be included in the plan and schedule.

1.3.4 SD-08 Statements

1.3.4.1 Excitation Equipment Removal Procedure; GA

The procedure shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations.

1.3.4.2 Installation Procedures; GA

The procedure shall include a detailed description of the methods and equipment to be used for each operation at each Project, and the sequence of operations. It shall also include the wiring plan for the control board modifications.

1.3.4.3 Factory Test Procedure; GA

A schedule, outline and detailed description of the test methods and equipment to be employed in all factory tests, including test values and rejection criteria and a list of instruments and equipment to be used.

1.3.4.4 Field Test Procedure; GA

A schedule for each Project, outline and detailed description of the test methods and equipment to be employed in all field tests, including test values and rejection criteria.

1.3.4.5 Contractor-Furnished Training; GA

Instructor background and qualifications, course outline and schedules, course material, and subject matter for the theory, and operation and maintenance of the excitation system. After the Operation and Maintenance manuals are approved and available for use, and at least 3 weeks prior to the beginning of training, a synopsis of the training curriculum shall be submitted.

1.3.4.6 Contractors Work Supervisors; GA

Submit information describing qualifications of proposed work supervisors.

1.3.5 SD-09 Reports

1.3.5.1 Materials; FIO

All materials incorporated into the work shall be tested, except as otherwise indicated or where such tests are waived in writing. If the Contractor desires to use stock material not manufactured specifically for the work covered by these specifications, evidence shall be submitted certifying that such material conforms to the requirements of these specifications, in which case detailed tests on these materials may be waived. Unless waived in writing, all tests or trials shall be made in the presence of a Government Quality Assurance Representative

(GQAR). The test reports shall be furnished as soon as practicable after the tests are made and shall be submitted in such form as to provide a means for determining compliance with the applicable specifications for the material tests.

1.3.5.2 Factory Tests; GA

The test report shall include descriptions of the tests performed, test results with tolerances, sample calculations, and the formulas used in determining the results of the tests. Unless waived in writing, all tests or trials shall be made in the presence of a Government Quality Assurance Representative (GQAR). The test reports shall be submitted within 14 calendar days after the tests are made. The following curves and data shall be included in the test report showing the:

a. Deleted.

b. Deleted.

c. Computation of excitation system ripple voltage.

d. Settings of all adjustable parameters, including the Power System Stabilizer parameters.

1.3.5.3 Field Tests; GA

Unless waived in writing, all field tests or trials shall be witnessed by the GQAR. Field test reports shall include copies of curves showing the characteristics of the exciter as determined by these tests, descriptions of tests performed, sample calculations, and formulas used in determining the results of the tests. Models and test data shall also be included in the field test reports. The test reports shall be submitted within 10 days after the tests are performed.

1.3.6 SD-19 Operation and Maintenance Manuals

Operation and maintenance manuals for all equipment furnished in this contract shall conform to the requirements of paragraph 1.10 Section 01330.

1.4 GOVERNMENT EQUIPMENT INTERFACE

1.4.1 DC Voltage Source-Control

Power from a properly protected, ungrounded, nominal 125 Vdc source, which has a range of 105 Vdc to 139 Vdc, for use in controlling the elements of the excitation and regulating systems.

1.4.2 DC Voltage Source-Field Flashing

Power from a properly protected, ungrounded, nominal 125 Vdc source, which has a range of 105 Vdc to 139 Vdc, for use in field flashing during start-up, not to exceed 80 amps.

1.4.3 AC Voltage Source-Lighting

120 Vac single-phase power for excitation system convenience receptacles and light fixtures.

1.4.4 Potential Transformers

Three potential transformers (PT's), rated 14,400/120 V, connected in a grounded wye configuration are available for each of units 1-3 at Lower Monumental and Lower Granite Project. The PT outputs shall be configured with knife switch test blocks. Connections to the PT signal for the purpose of input to the voltage regulator, PSS, or Line Drop Compensator shall be made so that a knife switch test block is between the connection point and the PT. If knife switch test blocks are not already properly located on the existing government equipment, they shall be supplied and installed by the Contractor.

1.4.5 Current Transformers

Three current transformers (CT), rated 8000:5 A, used for metering and relaying, are available for the power system stabilizers for units 1-3 at Lower Monumental and Lower Granite Projects. One CT, dedicated for the exciter and rated 8000:5 A, is also available on these units. The CT outputs shall be configured with knife switch test blocks. Connections to the CT signal for the purpose of input to the voltage regulator, PSS, or Line Drop Compensator shall be made so that a knife switch test block is between the connection point and the CT. If knife switch test blocks are not already properly located on the existing government equipment, they shall be supplied and installed by the Contractor

1.4.6 Switchboard Contacts

Generator lockout, Generator differential protection, master start relay contacts, and such other control, protective, and relaying devices that are located on existing switchboards.

PART 2 PRODUCTS

2.1 MATERIALS

All materials shall be new, and shall conform to the applicable requirements of these specifications. The classification and grade of materials incorporated in the work shall be in accordance with the specifications designated herein. Substitution of materials from those specified shall not be made except on specific prior written approval. Any materials required in the work not covered by specifications shall be submitted for approval for the purpose intended. Reference to any equipment, article, or catalog number shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may use any equipment, material or article which, in the judgment of the Contracting Officer, is approved as a suitable equal. The use of asbestos or polychlorinated biphenyl's (PCB's) shall not be permitted.

2.2 EXCITATION SYSTEM DESCRIPTION

2.2.1 General

The excitation system shall be a potential source rectifier exciter, including the rectifier assembly and the power potential transformer. The excitation system shall be a full inverting, with three phase rectifying bridges, microprocessor (digital) controlled and capable of continuous operation with powerhouse environmental conditions of 0 °C - 40 °C and 95 percent non-condensing relative humidity. The equipment provided under these specifications shall be a type having an established reputation of two years or more of satisfactory and reliable service, designed for field excitation and voltage regulation of hydroelectric generators 5 MVA and larger. The operation and performance of the equipment furnished shall be guaranteed by the manufacturer to meet the requirements of these specifications. All customer replaceable electronic parts shall be commonly available from commercial suppliers. No custom, selected, or matched parts shall be used.

2.2.2 Protection Against Stray Currents and RF Interference

The excitation system shall be adequately protected against stray currents and voltage surges. The excitation system shall be furnished with shaft voltage suppression for protection of the generator bearings against shaft voltages induced by the excitation system and for protection from generator out-of-step operation. The excitation system shall be designed and tested to be insensitive to radiated high-frequency interference such as that coupled from portable radio transmitters (typically 10-watt output in the 150MHz -174 MHz, 406MHz - 420MHz, 450MHz - 512MHz, 806MHz - 902MHz, 1.850GHz – 10990GHz band) operating within 1 meter of the exciter equipment.

2.2.3 Surge Withstand Capability

The excitation system shall be designed and tested or have been tested for surge withstand capability in accordance with IEEE C37.90.1.

2.2.4 Overspeed Protection

Any excitation system components supplied from the generator leads shall be capable of operation at 140 percent of rated frequency without damage and shall be provided with devices to protect the excitation system in case of overspeed operation.

2.2.5 Power Requirements

The design shall be such that the only requirements for station power are for:

a. 125 Vdc nominal field flashing as specified in paragraphs 1.4.2 and 2.3.3.3a. The exciter must be operable over the range of 103 to 140 Vdc and shall have adequate self-cooling capability for startup without the need of the 125 Vdc source for auxiliary cooling power;

b. 120 Vac for lighting and convenience outlets;

c. 125 Vdc nominal control power for operation of remote or local automatic control relays and operation of all remote inputs to the exciter including voltage raise/lower, automatic/manual control switching, local/remote control switching, power circuit breaker control, remote indication, annunciation, and protection.

d. 120 V preferred ac ungrounded for plant critical control equipment.

2.2.6 Noise Level

At no time during operation shall the excitation system cause noise levels exceeding 80 dB(A) within three feet of the cubicles.

2.3 EXCITATION SYSTEM PERFORMANCE CHARACTERISTICS

2.3.1 General

The excitation system shall be capable of supplying, without exceeding its nameplate continuous load rating, ample field excitation for the generator when the generator is delivering 115 percent rated kVA at rated power factor, rated frequency, and 105% voltage. It shall meet the requirements for a HIGH INITIAL RESPONSE EXCITATION SYSTEM as per IEEE 421.1. The excitation system shall be capable of supplying excitation system ceiling voltage for a minimum of at least 60 seconds without overheating the excitation system components.

2.3.2 System Characteristics

The excitation system shall be capable of the following performance:

Excitation System Nominal Response (For definitions see IEEE 421.2)	2.0
Source Voltage	70 percent rated
Negative Ceiling Voltage	70 percent of positive Ceiling Voltage

The excitation system shall be capable of achieving the nominal response at the specified source voltage.

2.3.3 Control System Features

2.3.3.1 General

The excitation systems shall be designed and have sufficient capacity for complete automatic operation for startup, normal operation, and shutdown of the generating units. Upon loss of external dc control power, the excitation system shall continue normal operation from back-up control power supply fed from the generator leads with annunciation of the failure of the primary power supply. Indicating lights, or conduction monitor, shall be provided to indicate and locate thyristor and/or diode failure.

2.3.3.2 Automatic and Manual Modes

The excitation system shall have the ability to be operated in either the manual or automatic modes as selected using a manual/automatic mode switch located on the exciter and on the unit switchboard. The manual mode normally is used when the automatic mode has failed and during testing. In either mode, control of the generator terminal voltage is accomplished by varying the amount of current in the field windings. Indicating lights at both control locations shall respond without regard to the position of the local/remote control switch, and shall conform to paragraph 2.4.21.

2.3.3.3 Operation Sequence

The sequence for normal operation in automatic mode shall be as follows:

a. When a generator unit start is initiated and the machine reaches 95 percent rated speed, the excitation system shall initiate field flashing which shall raise the machine terminal voltage to 20 percent rated voltage. The automatic voltage regulator shall then raise the terminal voltage to the normal preset voltage.

b. After the automatic voltage regulator has caused the generator terminal voltage to reach that level prescribed by the automatic voltage regulator set-point for speed-no-load (SNL), the regulator shall be capable of remote adjustment (either manually or through action of automatic synchronizer) to achieve the desired voltage set-point necessary to put the unit on line.

c. Operation of the automatic voltage regulator shall be as described in paragraph 2.4.5. Provisions shall be incorporated for the automatic reduction of excitation to a level safe for continuous operation after a predetermined time at ceiling or at abnormally high levels. If the automatic regulator fails to reduce the excitation to this lower level within the allotted time, automatic transfer to the manual regulator shall occur as described in paragraph 2.4.5. If the level of excitation remains high after transfer to the manual mode after an additional time delay, complete shutdown shall occur.

d. During generator shutdown, the regulator shall automatically reduce the manual and automatic voltage regulator set-points to the generator rated voltage, no-load level.

2.3.3.4 Diagnostics

Diagnostics and self tests shall be automatically performed on power-up of the voltage regulator to verify that the total hardware and software is fully operational. After power-up, the digital computer shall continuously verify that it is performing all of its tasks without error. Both on-line and off-line diagnostics shall be provided as follows:

a. On-Line Diagnostics

Digital control systems shall include software to continuously monitor hardware and software performance in real time with minimum

interference with normal system functions. The performance measurements shall be within 500 milliseconds. On-line diagnostics shall also be capable of the testing and adjusting of all settings, with provisions for remote on-line monitoring using a serial communications port.

b. Off-Line Diagnostics

A comprehensive set of off-line diagnostic programs shall be supplied. These diagnostics shall permit complete maintenance of all hardware elements. The off-line diagnostics shall permit, to the maximum extent possible, the diagnosis and isolation of any hardware fault without requiring additional test equipment. Test points shall provide for insertions of an arbitrary analog signal and for measuring the resulting output. Provision for a complete operational test of the voltage regulator, without energizing the generator, shall be included. All functional units shall be field repairable to the extent that replacement of a failed subassembly or module shall restore the unit to normal operating condition.

2.3.3.5 Terminal Interface and Software

2.3.3.5.1 Terminal Interface and Software for Initial Set-Up

a. Government Furnished Equipment. The Army Corps of Engineers Information Management Office (IMO) will provide a laptop computer for use as an exciter workstation terminal interface. The laptop configuration will include 256MB RAM, 20GB hard disk drive, CD-RW, floppy drive, Ethernet port, 2 USB ports, 1 serial port, 1 parallel port, PS/2 port, video port, PC card slot, Windows 2000 Professional operating system, Microsoft Office Professional suite, and Corps Enterprise Architecture allowed terminal emulation software.

b. Contractor’s software shall operate on the Government furnished equipment. Proven software suitable for set-up, adjustment and analysis of the excitation system shall be provided by the Contractor. The requirements of the Contractor provided system shall include the following as a minimum:

(1) System hardware, including the peripherals, communications, display, internal fixed, CD-ROM, floppy disk drives, and all required connectivity cabling.

(2) Digital application software, including the operating system, data base management software, compilers, and other utility programs. If specialized software is required it shall be approved by the Army Corps of Engineer’s Information Management Office (IMO) prior to use. Access to the software shall be password and key switch protected. Power failures shall not cause loss of the software.

(3) All equipment required for software editing, including configuration of protective features and changing of set-points at the job-site.

(4) The software shall facilitate step increase/decrease changes in all exciter operating modes including Automatic Voltage Regulator, and Field Current Regulator. The software shall allow the

user to first define the magnitude and direction of the step change and then initiate the step change by an “initiate” command. Provisions shall be supplied to record, download, and view the system response to the software generated step.

2.3.3.5.2 Terminal Interface and Software Installation, Operations and Maintenance (General)

The Army Corps of Engineers IMO will provide all hardware and software for laptop computer operations and maintenance. Installation and maintenance of this hardware and software shall adhere to the following requirements.

a. Laptops shall be Microsoft 2000 or higher compatible

b. Government provided terminal emulation software for the laptops are expected to be commercial off the shelf software

c. The Army Corps of Engineers IMO will perform all hardware and software upgrades for the laptops (to include procurement of hardware and software necessary for the upgrade).

d. All Government furnished hardware and software shall be within the suite of hardware and software allowed by the Corps’ Enterprise Architecture.

e. The Contractor shall notify the Army Corps of Engineers IMO a minimum of 10 business days in advance when changes in the operating requirements of the contractor provided digital exciters require the government provided hardware and/or software on the laptops to be upgraded.

2.4 EXCITATION SYSTEM EQUIPMENT

2.4.1 General

2.4.1.1 Equipment to be Included

The excitation system provided shall be complete and include but not be limited to the following: primary terminal chamber, current limiting fuses, excitation cubicles, power-potential transformer (PPT), rectifier assembly, AC conductors to transmit power from the PPT to the exciter cubicle, all auxiliaries necessary for satisfactory operation of the regulator such as control transformers, potentiometers, thyristors, transistors, operational amplifiers, digital controllers, resistors, rheostats, reactors, shunts, contactors and relays, and spare parts. The equipment shall be mounted in cubicles and shall be complete in every detail. It shall be ready for operation upon completion of installation and wiring. All additional external items required for proper operation and control shall be provided. All required bus work necessary to transmit dc power from the rectifier bridge to the brush-holders shall be provided by the installation contractor. Existing brush holders and brushes shall be reused with the new exciters. In addition, the installation contractor shall provide the AC bus feed from the generator bus to the high voltage side

of the power potential transformer. All additional external items required for proper operation and control such as control switches, transfer switches, and indicating lights shall be used with the equipment with the equipment provided under these specifications. New exciter field voltage and current meters shall be provided for the generating unit switchboard S panels. The excitation system design shall include the determination of required external items in addition to those devices, which are specifically called out herein. Switchboard devices shall be compatible, in function and appearance, with existing equipment.

2.4.1.2 Adaptation to Plants

The excitation equipment and all assemblies for interconnection of the exciter with existing equipment and facilities shall be custom fabricated for the site such that a minimum of on-site cutting and fitting is required. The equipment and assemblies shall include adaptive features to accommodate minor dimensional variations in existing equipment and structures.

2.4.1.3 Minimum Requirements from Standards

All equipment and materials shall be furnished and installed in accordance with NFPA 70 and the requirements of CFR 29 Part 1910. Omission of details on the Contract drawings, or in the specifications, shall not be construed as permitting deviations from NFPA 70. Rating, tests, and characteristics shall be in accordance with ANSI C50.10, ANSI C50.12, and IEEE 115, each as they apply, unless otherwise definitely specified.

2.4.1.4 Electronic Equipment Components

All electronic equipment, such as amplifiers and logic circuits, shall be of solid state design using industrial or military grade discrete transistors or integrated circuits bearing Joint Electron Device Engineering Council (JEDEC) registered device numbers, where possible. All components shall be suitable for operation at temperatures between 0 and 70 °C.

2.4.1.5 Digital Control Systems

The Contractor shall have responsibility for the design, manufacture, and testing of all digital control systems which are part of the supplied excitation equipment. Memory use for the operation program, configuration, and set-points shall be non-volatile, without the need for changing batteries, or for other maintenance, over the life of the excitation system. Each digital control system shall be equipped with at least one RS-485 communications port for communication with future control systems. In addition, the separate local control panel (LCP) / man machine interface (MMI) panels shall have the capability of communication of information necessary for control, display of operating values and annunication at remote locations. The digital exciter shall be capable of, and include communication protocol software for Modbus or other non-proprietary packetizing and error checking industry standard communications protocol for external communications. The communications software shall allow the plant distributed control system to perform all operational, display,

monitoring, alarm, and diagnostic features. Documentation for the communication card and communication protocol shall be included in the Operation & Maintenance manuals.

2.4.2 Power Potential Transformer

2.4.2.1 General

Power potential transformers shall be provided and shall be of the three-phase, 60 Hertz, self-cooled, ventilated dry type, or resin encapsulated windings type, conforming to the applicable requirements of IEEE C57.12.01, with 110 kv Basic Insulation Level (BIL) on the high voltage winding. The transformers furnished shall also conform to the recommended practice of IEEE C57.110 and shall be designed specifically for supplying a thyristor-controlled rectifier load. The transformers shall be of sufficient rating to deliver the required input power to the exciters under all generator operating conditions, with an average winding temperature rise by resistance not to exceed 80 °C. Hottest spot winding temperature rise shall not exceed 110 °C.

2.4.2.2 Transformer Mounting

The transformer shall be designed for floor mounting. The transformer shall be furnished with a primary voltage terminal chamber with provisions for the high voltage fuses and for terminating the 15 kV shielded cable. The transformer cabinet shall be built to match the excitation system cabinet and shall be constructed per the requirements described in paragraph 2.4.8. Floor mounts with appurtenances shall be furnished for the PPT.

2.4.2.3 Temperature Indication

The transformer shall also be furnished with a temperature indicator mounted on the transformer windings housing in a manner that facilitates reading of the indicator from the maintenance aisle. The temperature indicator shall be equipped with a minimum of two normally open contacts to provide alarm and trip functions. The contacts shall be wired to terminal blocks in the secondary bus transition section for routing to the exciter cabinet for use in annunciation and excitation trip.

2.4.2.4 Current Transformers and Metering

Three suitable relaying accuracy current transformers (CT’s) shall be mounted in the transformer secondary for use with the transformer protection relays.

2.4.2.5 AC Conductors Between PPT and Rectifier Supply Breaker

The AC conductors from the PPT to the rectifier supply circuit breaker shall be of properly sized and rated insulated copper conductor cables suitable for installation in rigid galvanized steel conduit. If the rectifier supply breaker cabinet is designed for location adjacent to the PPT, segregated phase bus will be permitted for the connection. Insulated copper conductor cables shall meet the requirements of paragraph 2.4.12.

2.4.3 Rectifier Supply Breaker

The Contractor shall provide a three-pole, adequately rated, rectifier supply air circuit breaker for the excitation system, conforming to the requirements of NEMA SG 3 and suitable for the excitation system. The breaker shall be provided with arc extinguishers and the operating mechanism shall be trip-free in all positions. It shall be of the drawout type arranged for remote 125 Vdc electrically trip-free operation. The breaker shall be provided with sufficient (a minimum of three type 'a' and three type 'b') auxiliary contacts, including a spare type ‘a’ and a spare type ‘b’ contact , meeting the requirements of paragraph 2.4.15. The breaker shall be rated not less than the maximum continuous current of the circuit under the specified full load operating conditions of the generator, and shall also be capable of interrupting the available fault current under maximum possible short circuit conditions. The contacts shall be of the type, which are readily accessible for inspection and replacement. A circuit breaker enclosed in a molded case will not be acceptable. The breaker shall be placed in its mounting cubicle in such a way that it can easily be withdrawn for inspection and testing. A local control switch shall be provided to open and close the exciter breaker at the exciter cubicle.

2.4.4 Rectifier Assembly

2.4.4.1 General

Rectifier assemblies shall be full-inverting type. Thyristors and diodes of rectifier assemblies shall have a minimum rating of 350 percent of the rectifier nameplate RMS voltage rating. Thyristors and diodes shall have a peak inverse voltage rating greater than 2.75 times the PPT nominal secondary voltage. Rectifier assemblies shall be constructed to allow ready access for inspection and replacement of thyristors and diodes. The rectifier assembly shall be placed in its mounting cubicle in such a way the thyristors and diodes can easily be withdrawn for inspection and testing.

2.4.4.2 Rectifier Assembly Cooling

Cooling for rectifier assemblies shall be by forced air convection. Fan cooling shall consist of two sets of fans either of which can supply sufficient cooling air to keep the rectifier assembly within the normal operating temperature limits of the assembly components when delivering rated output continuously. Circuits that supply power to the cooling fans shall be designed such that no single cause initiating event will remove power from both cooling fans. Bridge temperature and cooling air flow monitoring and alarm circuits shall be powered independently from fan cooling power sources. A protective scheme shall be provided to automatically throw over to the alternate set of fans upon loss of primary fans. Manual-auto and lead-lag mode selector switches shall be included for fan operation. Reset switches shall be provided for returning the lead-selected fan to operation. An anemometer or vane switch, or air pressure switch shall be provided for monitoring air flow in the rectifier assemblies. The forced air cooling system shall include air filters. Filters shall be of large cross-sectional area to ensure a low pressure drop and shall be of a type easily replaceable without tools. Inlet air shall not be drawn

from near the floor to prevent rapid clogging of the air filters. Filters shall be either aluminum, electrostatic, washable, permanent, or reusable. If aluminum filters are furnished, they shall contain layers of expanded aluminum laid at right angles to one another to achieve maximum filtering. The rectifier assembly shall have sufficient capacity to allow startup of the generator without the need for external station service power.

2.4.4.3 Rectifier Protective Circuitry

The rectifier assembly shall be supplied with transient overvoltage protection and non-explosion type protective fuses. Protective circuitry shall be furnished to provide a path for the field current and to dissipate the stored energy in the field. The circuitry shall incorporate bi-directional thyristors with a field discharge resistor or similar approved circuitry.

2.4.4.4 DC Conductors Between Exciter and Collector Rings

The DC conductors from the exciter to the collector ring brush assembly shall be of properly sized and rated prefabricated nonsegregated phase bus of rated enclosed construction and bare or insulated copper conductors. Bus ambient temperature will be 40° C (104° F). The nonsegregated phase bus shall meet the requirements of paragraph 2.4.11. The bus shall be designed with joints as required to facilitate ease of bus removal during maintenance.

2.4.5 Voltage Regulator

2.4.5.1 General

The voltage regulator shall contain automatic and manual regulator sections. The voltage regulator shall be provided with all the required switches, voltage control adjusters, and indicators such that complete local control at the exciter is provided for testing and maintenance purposes. The regulator shall obtain its motive power from the power potential transformer, independent of station ac power and the station battery. The regulator shall obtain power from the station battery for field flashing and for control power. The regulator shall be equipped with adjustable elements excited from the generator potential transformers and current transformers, which will automatically limit the decrease of generator excitation to avoid loss of generator synchronism with the system. Such devices, however, must allow the regulator to reduce the excitation voltage to zero or reverse it to prevent overvoltage in case of operation under line charging conditions or overspeed of the unit. The regulator shall remain in service upon generator load rejection. The manufacturer's standard products will be allowed to be used for the local control devices, subject to approval of the Contracting Officer.

2.4.5.2 Voltage Regulator Characteristics

The synchronous machine voltage regulator shall be a continuously acting regulator with the following characteristics:

Voltage accuracy (with steady-state load conditions within operating range of regulator)	± 0.2 percent

Maximum generator voltage change (with slow changes in ambient temperatures from 15 to 40 °C, after regulator elements have stabilized)	± 0.2 percent
Maximum generator terminal voltage percent of voltage setting (with steady-state conditions, generator open-circuited, generator speed up to 150 percent of nameplate)	105 percent

2.4.5.3 Automatic Voltage Regulator

The automatic voltage regulator (ac regulator) shall control generator terminal voltage by continuous comparison of the average three-phase voltage of the generator with a reliable reference voltage source. The error voltage shall be amplified and applied to the excitation system in such a manner as to adjust generator voltage to reduce the error. The automatic voltage regulator shall be capable of remote operation, and have preset voltage levels representing "minimum" - 11.7 kV, "normal Speed-No-Load (SNL)" - 13.8 kV, and "maximum" – 15.2 kV, and shall provide outputs for interfacing with 125 Vdc remote indicating lights.

2.4.5.4 Automatic Voltage Regulator Exciter Voltage Adjuster

The automatic voltage regulator shall include a generator voltage adjuster, which shall give a range of voltage control of -15 percent to +10 percent of rated voltage. The voltage adjuster shall be suitable for operation with 125 Vdc remote contacts and shall be provided with adjustable limiting functions to stop the adjuster at the range limits and to energize indicating lamps, and Supervisory Control and Data Acquisition (SCADA) inputs, at each end point.

2.4.5.5 Manual Regulator

The manual regulator (dc regulator) shall operate in a similar fashion to the automatic regulator, except that it shall compare generator field voltage or current to a reliable reference source, and control excitation voltage or current to reduce the error between them. All necessary switches shall be provided which will enable manual control of the regulator from the unit switchboard when the selector switch is placed in the remote position. The manual regulator shall be capable of local-manual and remote operation, have preset voltage levels representing "minimum" - 3.5 kV, “normal Speed-No-Load (SNL)” 13.8 kV, and "maximum" – 14.5 kV, and shall provide outputs for interfacing with 125 Vdc remote indicating lights.

2.4.5.6 Manual Voltage Regulator Exciter Voltage Adjuster

The manual voltage regulator shall include an exciter voltage adjuster which shall provide for adjustment of excitation voltage from 25 percent of rated to that excitation voltage required for generator operation at 115 percent rated load, rated power factor, and 105 percent rated generator voltage. The adjuster shall be suitable for 125 Vdc operation, and it shall be configured for remote operation.

Adjustable limit functions shall be provided to stop the adjuster at range limits and also to operate remote indicating lamps to show the upper and lower limit positions. The adjuster shall have provisions to return to the normal no-load voltage position.

2.4.5.7 Automatic/Manual Regulator Transfer

Automatic tracking shall be provided to accomplish bumpless transfer during startup, control mode change, and shutdown from the automatic voltage regulator to the manual voltage regulator or from the manual voltage regulator to the automatic voltage regulator. During regulator transfer, field excitation disturbance shall not exceed 1 percent of the desired excitation. Regulator transfer shall be capable of remote operation and shall provide outputs for interfacing with 125 Vdc remote indicating lights for indication of "manual" or "regulator" mode.

2.4.5.8 Automatic Transfer to Alternate Regulator Settings

The automatic voltage regulator may be tuned by the Government to operate with settings that are different when the power system stabilizer is in service than when the stabilizer is off. The voltage regulator shall be capable of storing these two sets of parameters and shall automatically transfer from one set to the other when the PSS status signal changes. This transfer shall be bumpless and shall be made while the unit is on line.

2.4.5.9 Automatic Failover Control

The voltage regulator shall continuously monitor its own function. When failure of the automatic voltage regulator is detected, (such as with a PT fuse failure, detection of a critical loss of control condition, or a processor failure indicated by the watch-dog timer) transfer to a separate, independent regulator controller operating as a manual regulator shall be automatic and shall not cause generator shutdown. In the event of sustained overexcitation, a transfer from automatic voltage regulation to manual voltage regulation shall occur after an adjustable time delay. If this overexcitation condition persists after an additional adjustable time delay in the manual regulation mode, the excitation system shall automatically shut down and shall initiate a generator shutdown. Auxiliary contacts for indication and annunciation of these failures shall be provided.

2.4.6 Power System Stabilizer (PSS)

2.4.6.1 General

The exciter voltage regulator shall include a Power System Stabilizer (PSS). The PSS can be software implemented or externally hard-wired to the regulator. The PSS provided under these specifications shall be designed for hydroelectric generators 7 MVA and larger. The PSS shall also be a type having demonstrated two years or more of satisfactory service after being tuned to Western Electricity Coordinating Council (WECC) criteria as specified in “Test Procedures for Power System Stabilizers”, WSCC Paper dated 1976. The device shall operate to supplement the voltage regulating action by adding an additional signal into the excitation system input. The PSS shall be tunable to provide

damping at local mode (1-1.5 Hz) and inertia mode (0.2 to 0.7 Hz) frequencies.

2.4.6.2 Configuration

The PSS shall be of the dual–input design, defined as Type PSS2A in "Computer Models for Representation of Digital-Based Excitation Systems," IEEE/PES paper 96 WM 031-5 EC. The PSS shall be of digital design.

2.4.6.2.1 Limiter

An adjustable limit shall be provided to prevent the stabilizer signal from exceeding –0.25 to 0.3 per unit change in terminal voltage. A "wash-out" function shall be provided to prevent permanent bias of voltage for a steady state speed error. The PSS signal to the automatic voltage regulator input shall be removed when terminal voltage of the generator exceed an adjustable level from +/- 5% to +/- 10%.

2.4.6.2.2 Low Power Cutoff Circuit

A low power cutoff circuit shall be provided to remove the PSS signal to the regulator. This circuit shall be adjustable from zero to 40 percent of generator real power output.

2.4.6.2.3 Regulator Manual Operation

Logic shall be provided to automatically remove the PSS signal to the regulator when the regulator is operated in the manual mode.

2.4.6.3 Input Signals

PSS input signals shall be electrical power and rotor speed or compensated frequency. The power signal shall be derived from an instantaneous watt transducer or equivalent digital algorithm, using three phase voltage and current input signals. The speed signal shall be derived from a measurement or calculation of compensated terminal frequency. Accuracy of the two measurements shall be within 1% of full range. The effective time constant associated with the power and speed measurements shall be no greater than 20 ms and there shall be less than 10 ms difference between the two input channels. Where compensated frequency is used as the replacement for measured speed, the equipment shall sum terminal voltage with the quadrature component of terminal current. Compensation shall be equivalent to the quadrature synchronous reactance of the generator. This compensation shall be continuously adjustable over a range of 0.0 to 0.5 per unit on the generator per unit base. Direct measurement of terminal frequency is not acceptable as a PSS input.

2.4.6.4 Settings

The PSS shall accommodate the following range of settings:

The high-pass filters shall allow for time constants of up to 20 seconds (T_{W1}, T_{W2}, T_{W3}, T_{W4})

The "mechanical-power" filter shall provide attenuation of at least 40 dB at 10 Hz and shall be of the "ramp-tracking" configuration to minimize terminal voltage excursions during mechanical power variations. Specifically the stabilizer output change shall not exceed 1% of terminal voltage reference with a stabilizer gain of 10 per unit $E_{t\text{-}ref}$/per unit speed, for mechanical power ramp rates of 0.1 per unit/second. (T_8, T_9, N, M selected to meet above criteria).

The stabilizer gain (K_{S1}) shall be adjustable between 0 per unit $E_{t\text{-}ref}$/per unit speed and 50 per unit $E_{t\text{-}ref}$/per unit speed.

The phase lead circuit shall provide for a wide range of phase compensation settings. A normal range of adjustment for the phase lead time constants is:

$T_1 = T_2 = 0.01$ to 6.0 seconds
$T_3 = T_4 = 0.02$ to 6.0 seconds

The software shall allow for addition of a third phase lead stage for special cases.

Stabilizer signal output limits shall be provided. A normal range of adjustment for the limits is:

$V_{STMAX} = 0.0$ to 0.3 per unit
$V_{STMIN} = 0.0$ to -0.25 per unit

If a terminal voltage limiter is not provided as part of the excitation system, the positive stabilizer signal output limit may have to be coordinated with generator overvoltage protections.

All settings must be adjustable while the unit is running.

2.4.6.5 Test and Status Monitoring Features

To ensure that the stabilizer can be properly maintained and tested, all critical internal signals shall be accessible to allow for verification of the correct functional operation of the stabilizer. This function shall be provided through digital data collection or through assignment of computed variables to D/A interfaces. Facilities must be provided to allow for safe testing of the stabilizer with the generator operating on-line.

2.4.7 Line Drop, Droop, and Reactive Differential Compensation

Devices providing for line drop compensation (LDC), to regulate generator VAR output according to transmission line impedance losses, shall be furnished. Devices providing for droop compensation, to reduce the voltage at the generator as a function of the flow of real and reactive current to stabilize sister unit VAR oscillations, shall be furnished. The exciter must be capable of concurrent operation in the Line Drop and Droop compensation modes. Additionally, Reactive Differential Compensation is required. Devices providing for cross current and line drop compensation by direct active measurement of sister unit instantaneous output, shall be furnished.

2.4.8 Equipment Cubicles

2.4.8.1 General

Metal enclosed cubicles of NEMA 250 Type 1 fabrication shall be furnished to house the excitation system and synchronous machine voltage regulator equipment. The complete cubicle lineup, not including the Potential Power Transformer section, shall not exceed 90 inches in width, 90 inches in depth with the doors open perpendicular to the cubicle or pullout drawers fully extended, and 90 inches in height from the floor line to the uppermost projection on the cubicle. This maximum height does not include the enclosure for the feed from the Power Potential Transformer. Lifting angles which are to be removed after installation need not be counted in the dimensional limits. All dimensions shall be verified in the field by the Contractor. All access to internal components shall be by means of hinged doors and shall comply with the working space requirements of NFPA 70. The door openings shall be designed so that they can be fully opened without interfering with existing equipment or structures. The cubicles shall be arc-flash or explosion rated if the equipment has been assessed for arc-flash and shall have appropriate warning signs.

2.4.8.2 Cubicle Construction

The cubicles shall be of the totally enclosed, free-standing, dead-front type built on a suitable framework of structural steel or by an equivalent approved method. Each cubicle shall consist of rigid, self-supporting, enclosed panels with full length doors or pullout drawers arranged to provide easy access to the equipment. The enclosures shall be made of selected smooth sheet steel panels, suitably supported. Doors and panels used to support instruments and other devices and barriers between compartments shall not be less than No. 12 gauge steel. Doors shall be mounted with manufacturer’s standard hinges. Exposed panels on the front and ends of the enclosures shall be bent angle or channel edges with all corner seams welded and ground smooth, or shall be the manufacturer's equivalent construction as approved by the Contracting Officer. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. With the exception of nameplates, self-tapping screws will not be allowed.

2.4.8.3 Louvers and Latches

Punched louvers necessary for adequate ventilation shall be provided where required. Louvers shall be designed or screened to prevent the entrance of insects and rodents. All doors shall be equipped with a handle, a three-point latch, and flush lock. The locks shall have removable cores, and six control keys shall be provided for removal of the lock cores.

2.4.8.4 Channel Iron Foundations

Continuous channel iron foundations, complete with bolts and drilled holes for grouting and anchoring to the floor, shall be furnished for the complete length front and rear of the cubicle assembly. Channel construction and drilling shall be as required for mounting the

equipment. The channels shall be designed for flat mounting and the maximum channel depth shall be 2-1/2 inches.

2.4.8.5 Grounding

Each cubicle shall be provided with a continuous interior copper ground bus to which the housing, framework, cable and bus supports, and non-current-carrying metallic parts of all equipment shall be grounded insofar as practicable. Grounding shall conform to paragraph 6.1.2 of IEEE C37.20.1, except that the ground bus bar shall not be less than 1 inch by 1/4 inch in size. Ground connections shall be made by approved clamp-type fittings; soldered connections shall not be used. Splices in ground buses between shipping sections shall be provided with bolted connections having scarified contact surfaces coated with an approved deoxidizing agent. Bus bar splice contact surfaces shall be silver-plated. Jumper cables or copper bars shall be provided for connecting the ground bars at shipping splits. Multigrip clamp-type cable terminals for No. 2/0 AWG cables shall be provided for connection to the station grounding system for each ground bus. Control cable shields shall be grounded only once.

2.4.8.6 Convenience Receptacles, Light Fixtures, and Switches

Lighting switches shall be rated for 20 A, 277 Vac and shall be quiet in operating and suitable for use at full rated capacity on inductive loads. Light fixtures shall be provided with suitable guards in each equipment cubicle. Receptacles shall be duplex, Hospital Grade, with ground, rated for 20 A, 125 Vac with NEMA 5-20R configuration. A convenience receptacle and light fixture with switch shall be provided in each equipment cubicle. The convenience receptacles shall be located towards the front of the equipment cubicles. The location of the receptacle and light switch shall be where access to them can be made without reaching over or under exposed energized conductors.

2.4.8.7 Painting

The interior and exterior steel surfaces of the excitation system equipment enclosures, including the power potential transformer and fuse cabinet enclosures, shall be thoroughly cleaned after fabrication by sandblasting, pickling and rinsing, or by other means. They shall then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting in accordance with paragraph 6.1.5 of IEEE C37.20.2. Exterior surfaces shall then be primed, filled where necessary, and given not less than two coats of quick air-drying lacquer or synthetic enamel with semigloss finish or heat fused epoxy power coating of a color that matches the color scheme of the plant. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Bus ducts shall also be painted to match the existing color scheme at the plants.

2.4.9 Connections

All bolts, studs, machine screws, nuts, and tapped holes shall be in accordance with ASME B1.1. Threads for sizes 1/4 inch to 1 inch, inclusive, shall be NC or UNC series. The sizes and threads of all valves, pipe and fittings, conduit and fittings, tubing and fittings, and connecting equipment shall be in accordance with ASME B1.20.1.

Manufacturer's standard thread and construction may be used on small items, which in the judgment of the Contracting Officer, are integrally replaceable, except that threads for external connections to these items shall meet the above requirements.

2.4.10 Potential Source Power Supply

2.4.10.1 Generator 13.8 kV Bus Tap

The Contractor shall install the tap for exciter power to the 13.8 KV generator bus in such a fashion as to maintain the integrity of the existing Isolated Phase Bus (IPB) system. It is acceptable for the interconnecting cable from the IPB system to the Power Potential Transformer (PPT) to be made in a single rigid metallic conduit provided that high interrupting capacity fuses, in an isolated phase arrangement, are utilized at the tap point before allowing all power cables to be combined into a single conduit.
Contractor shall submit, for government approval, proposed method and routing of such installation prior to commencing work.

2.4.10.2 Current Limiting Fuses

Current limiting fuses shall be sized, specified, and provided by the contractor, taking into account the damage points for cable and equipment, and shall be mounted in the generator air housing. Submit calculations and catalog cuts for approval with the bus tap design.

2.4.10.3 AC Conductors Between Generator Bus and Power Potential Transformer (PPT)

The ac conductors from the generator tap to the power potential transformer shall meet the design standards of the existing generator bus and be of properly sized and rated insulated copper conductor cable and rigid galvanized steel conduit. Insulated copper conductor cable shall meet the requirements of paragraph 2.4.12.

2.4.11 Copper Bars and Rods

Copper bars and shapes for dc ground bus conductors shall conform to the requirements of ASTM B 187 and ASTM B 188.

2.4.12 Insulated Wire and Cable

2.4.12.1 General

All wire and cable used for power, lighting, control, metering, and relaying systems shall be provided by the Contractor and shall conform to the requirements specified herein. Characteristics, including conductor size, stranding, number of conductors, rated circuit voltage, cabling, and other requirements for each type of service, shall be as indicated on the drawings, or as specified under the detailed requirements of these specifications for the particular construction or use, unless otherwise stated. Wire conductors and cables shall comply with the following table: (See next page)

NEC/TRADE TYPE	Conductors	Maximum Operating Temperature	Application	Insulation Type	Conductor Insulation Thickness
SIS	Single Conductor	90º C	Switchboard wiring only	Thermoset 600 volt	0.76 mm
RHH	Single conductor or multiple conductor cable	90º C	Conduit (single conductor) or cable tray (multiple conductor cable) Multiple conductor cables must be tray cable rated for cable tray installation	Conductor-Thermoset 600 volt Cable insulation – non-PVC 600 volt	1.14 mm
RHW	Single conductor or multiple conductor cable	75º C	Conduit (single conductor) or cable tray (multiple conductor cable) Multiple conductor cables must be tray cable rated for cable tray installation	Conductor-Thermoset 600 volt Cable insulation – non-PVC 600 volt	1.14 mm
XHHW	Single conductor or multiple conductor cable	90º C	Conduit (single conductor) or cable tray (multiple conductor cable) Multiple conductor cables must be tray cable rated for cable tray installation	Conductor-Thermoset 600 volt Cable insulation – non-PVC 600 volt	1.14 mm for single conductor 0.76 mm for multiple conductor cable conductors
TC	Multiple Conductor Cable (general) Individual conductors shall be RHH, RHW, or XHHW	75º C	Tray cable rated for cable tray installation	Cable insulation - non-PVC 600 volt	

2.4.12.2 Wire and Cable Schedule

Wire and cable shall be furnished in accordance with the requirements of the Conduit and Cable Schedules, and as indicated on the drawings. Estimated quantities listed in the Conduit and Cable Schedules are approximate for bidding purposes.

2.4.12.3 Governing Standards

Materials, construction and tests, unless otherwise specified, shall conform to the applicable requirements of NEMA WC 70.

2.4.12.4 Rated Circuit Voltages

Wire and cable for circuits operating at 600 volts and below shall have minimum rated circuit voltages in accordance with Section 3 of NEMA WC 70.

2.4.12.5 Conductors

2.4.12.5.1 Material

Conductors shall conform to all the applicable requirements of Section 2 of NEMA WC 70 and shall be annealed copper. Copper conductors may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

2.4.12.5.2 Minimum Wire Sizes

Minimum wire size shall be No. 12 AWG for power and lighting circuits; No. 10 AWG for current transformer secondary circuits; No. 14 AWG for potential transformer, relaying, and control circuits; and No. 16 AWG for annunciator circuits.

2.4.12.5.3 Stranding

Conductor stranding classes cited herein shall be as defined in Appendix G of NEMA WC 70. Lighting conductors No. 10 AWG and smaller shall have Class C stranding as defined in Table 1 of ASTM B 8. Any conductors used between stationary and moving devices, such as hinged doors or panels, shall be Class H or K stranding. All other conductors shall have class C stranding.

2.4.12.6 Insulation

2.4.12.6.1 Insulation Voltage Rating and Insulation Level

The rated voltage of the insulation shall be 600 volts for all circuits operating below 2,000 volts, with 100 percent insulation level. The rated voltage of the insulation shall be 15,000 volts for all circuits operating above 2,000 volts, with 133 percent insulation level.

2.4.12.6.2 Insulation Material

Insulation shall be cross-linked-thermosetting-polyethylene (XLPE) type, or an ethylene-propylene-rubber (EPR) type meeting the requirements of

Section 3 of NEMA WC 70. Polyvinyl chloride (PVC) insulation will not be accepted.

2.4.12.6.3 Insulation Thickness

The insulation thickness for single-conductor cables and single conductors of multiple-conductor control cables used for control and related purposes rated below 2,000 volts shall be as required by Section 3 of NEMA WC 70.

2.4.12.7 Shielding

Shielding, where specified for control cables rated below 2,000 volts, shall conform to the requirements of Part 4 of NEMA WC 57.

2.4.12.8 Jackets

All cables shall have jackets meeting the requirements of Section 4.1 of NEMA WC 70, and as specified herein. Individual conductors of multiple-conductor cables shall be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, except for shielded cables, shall be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables shall be provided with a common jacket, which shall be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including the jacket, afterward fully meets these specifications and the requirements of the applicable standards.

2.4.12.8.1 Jacket Material

The jacket shall be one of the materials listed below, in accordance with the applicable paragraphs of NEMA WC 70. Polyvinyl chloride compounds will not be permitted. Variations from the materials required below will be permitted only if approved for each specific use, upon submittal of sufficient data to prove that they exceed all specified requirements for the particular application.

a. Neoprene, heavy-duty black.

b. Chlorosulfonated polyethylene, heavy-duty.

c. Chlorinated polyethylene, cross-linked, heavy-duty.

2.4.12.8.2 Jacket Thickness

The minimum thickness of the jackets at any point shall be not less than 80 percent of the respective nominal thickness specified below:

a. Thickness of the jackets of the individual conductors of multiple-conductor cables shall be as required by Section 4.1 of NEMA WC 70, and shall be in addition to the conductor insulation thickness required by Section 3 of NEMA WC 70 for the insulation used. Thickness of the outer jackets or sheaths of the assembled multiple-conductor cables shall be as required by Section 4.1 of NEMA WC 70.

b. Single conductor cables, if nonshielded, shall have a jacket thickness as specified in Section 4.1 of NEMA WC 70. If shielded, the jacket thickness shall be in accordance with the requirements of Section 4.1 of NEMA WC 70.

2.4.12.9 Identification

Only one color-code method shall be used for each cable construction type. Colored braids will not be permitted. Control cable color-coding shall be in accordance with Appendix E of NEMA WC 57. Power cable color-coding shall be black for Phase A, red for Phase B, blue for Phase C, white for grounded neutral, and green for an insulated grounding conductor, if included.

2.4.12.10 Cabling

Individual conductors of multiple-conductor cables shall be assembled with flame and moisture-resistant fillers, binders, and a lay conforming to Part 5 of NEMA WC 57, or Section 5 of NEMA WC 70, as applicable, except that flat twin cables will not be permitted. Fillers shall be used in the interstices of multiple-conductor round cables with a common covering where necessary to give the completed cable a substantially circular cross section. Fillers shall be of a non-hygroscopic material, compatible with the cable insulation, jacket, and other components of the cable. The rubber filled or other approved type of binding tape shall consist of a material that is compatible with the other components of the cable and shall be lapped at least 10 percent of its width.

2.4.12.11 Dimensional Tolerance

The outside diameters of single-conductor cables and of multiple-conductor cables shall not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

2.4.12.12 Flame Tests

All multiple-conductor and single-conductor cable assemblies shall pass the IEEE Standard 383 flame tests, paragraph 2.5, using the ribbon gas burner. Single-conductor cables and individual conductors of multiple-conductor cables shall pass the flame tests of Part 3 of NEMA WC 57 or Section 6 of NEMA WC 70, as applicable. If such tests, however, have previously been made on identical cables, these tests need not be repeated. Instead, certified reports of the original qualifying tests shall be submitted.

2.4.12.13 Independent Tests

The Government may at any time make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high-potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

2.4.12.14 Packaging and Marking

The cables shall be furnished one length to a reel or coil. Each length, and the outside of each reel or coil, shall be plainly marked or tagged to indicate the cable length, voltage rating, conductor size, and manufacturer's lot number and reel number. Cables for exclusively dc applications shall be identified as such. Reels shall remain the property of the Contractor.

2.4.12.15 Switchboard Wire

Wiring provided in the existing switchboard shall be single conductor #14 AWG, 600-volt, Type SIS, or approved equal meeting the requirements of UL 44. Stranding shall be Class B or Class C.

2.4.13 Molded Case Circuit Breakers

2.4.13.1 General

Molded case circuit breakers shall conform to the applicable requirements of NEMA AB 1, NEMA AB 3, and UL 489, shall be fully rated, and shall have voltage ratings and interrupting ratings hereinafter stated. The circuit breakers shall be manually operated and shall have trip-free operating mechanisms of the quick-make, quick-break type. All poles of each breaker shall be operated simultaneously by means of a common handle, and shall be enclosed in a common molded plastic case. The operating handles shall clearly indicate whether the breakers are in "On," "Off," or "Tripped" position. All double-pole, 125 Vdc molded case circuit breakers for the control and field flashing circuits shall conform to the applicable requirements of NEMA AB 1 and shall be of the heavy duty type. Circuit breakers shall be equipped with means for a mechanical lockout device.

2.4.13.2 Trip Units

The circuit breakers shall be of the automatic type provided with combination thermal and instantaneous magnetic trip units. Instantaneous magnetic trip units shall be set at approximately 10 times the continuous ratings of the circuit breakers.

2.4.13.3 120 Vac Circuits

Circuit breakers for 120 Vac circuits shall be rated not less than 250 Vdc, and either 120/240 or 240 Vac, and shall have a minimum NEMA interrupting capacity of 10,000 A symmetrical.

2.4.13.4 125 Vdc Circuits

Circuit breakers for 125 Vdc circuits shall be two-pole rated 125/250 or 250 Vdc and shall have a minimum NEMA interrupting capacity of 10,000 Adc.

2.4.14 Field Flashing Source

2.4.14.1 Field Flashing Circuit Breakers

New circuit breaker shall be provided in the spare compartments of the existing dc distribution panels on the unit switchboard panels, located on the generator floor at elevation 640 (Lower Granite) and elevation

444 (Lower Monumental), which will be used for field flashing. The circuit breaker shall meet the requirements of paragraph 2.4.13.1. The distribution panels are General Electric products and the recommended part number of the new breakers is GE TEB 122090.

2.4.14.2 Field Flashing Cable

Field flashing cabling shall be size AWG 2, meeting the insulation requirements of paragraph 2.4.12.6

2.4.15 Auxiliary and Interposing Relays

Auxiliary and interposing relays shall be of the self-reset type and shall be provided with convertible contacts. Relay coils and contacts shall be suitable for continuous operation in 125 Vdc or 120 Vac circuits as required. Contacts shall have a 10 A continuous current rating. The single-contact inductive load interrupting capacity shall be not less than 1.0 A for 125 Vdc or 6 A for 120 Vac. Relays used in 125 Vdc circuits shall operate reliably between 90 and 140 Vdc. Relay coils used in 125 Vdc circuits shall be capable of handling 140 Vdc continuously. All inductive devices, such as relays and solenoids, shall be provided with suppression devices to limit surge voltages, which may be generated when the coil circuits are interrupted.

2.4.16 Protective Relays

If externally mounted protective relaying is required, solid-state type relays shall be provided and mounted in the excitation cubicles. The relays shall conform to the applicable requirements of IEEE C37.90. The relays shall be back-connected, semiflush-mounted, switchboard type with rectangular, dust-tight cases, removable covers and screw connections. The relays shall be drawout type with built-in test facilities arranged so that the relays can be tested in position or withdrawn from the fronts of the cases without opening current transformer secondary circuits, disturbing external circuits, or requiring disconnection of leads from the relay terminals. Each relay shall be provided with one or more operation indicators and/or indicating contactor switches with targets and external target reset devices. The circuits shall be arranged for positive target operation. Seal in contactors and suitable loading resistors shall be provided where required. Separate relay operating functions, such as instantaneous trip attachments, shall have separate targets and contacts. Relay contacts shall be silver-to-silver, electrically independent, chatter proof and non-bouncing. The relays shall meet the transient immunity requirements of IEEE C37.90. Each relay shall control a minimum of two auxiliary contacts for unit shutdown and/or annunciation.

2.4.17 Control and Instrument Switches

Control or instrument switches shall be of the rotary switchboard type with handles on the front and the operating contact mechanism on the rear of the panels. Each switch shall be provided with ample contact stages to perform the functions of the control system. Contacts shall be self-aligning and shall operate with a wiping action. A positive means of maintaining high pressure on closed contacts shall be provided. All control switches shall be capable of operation on 600

Vac or 250 Vdc circuits. The switches shall be capable of continuously carrying 20 A without exceeding a temperature rise of 30 °C. The single-break inductive load interrupting rating of switches shall be not less than 1.5 A for 125 Vdc or 10 A for 115 Vac. Each control switch shall be provided with an escutcheon clearly marked to show each operating position. The switch identifications shall be engraved on the escutcheon plates and on separate nameplates.

2.4.18 Speed Switches

New speed switches shall be furnished and mounted in the permanent magnet generator (PMG) of each unit. They shall be electronic type with contacts that close at and above 95 percent unit speed. The contacts shall meet the requirements of paragraph 2.4.16. Switches shall have a minimum of 1 normally open contact, and 1 normally closed contact. Contacts shall be electrically separate. The speed switches shall be used to initiate start and shutdown of the excitation system.

2.4.19 Exciter Display

2.4.19.1 General

Operation and monitoring functions under normal operating conditions shall be provided through a flush mounted LCD or flat screen display and keypad or touch screen display on the exciter cubicle. The display on the exciter cubicle shall provide for local control of the excitation system, diagnostic display, and fault display. All of the information and controls described in this section shall be accessible by PC through a serial communications interface on the control and display panel. The control panel shall incorporate a software program developed to control and monitor the excitation system. Through use of this program with a PC, a user shall minimally perform on-line changes to the excitation systems application program, observe system programs, status, alarms, and parameters, and change parameter values.

2.4.19.2 Exciter Operation Display

The operation display shall provide indication of operational parameters and status of exciter features through the front panel display and keyboard. The Contractor’s standard display parameters shall be provided and shall include the following:

a. Exciter ID
b. Regulator AUTO/MANUAL Operation
c. Automatic and manual regulator voltage set-points
d. SCR firing status
e. Limiter and protective device status
f. Limiter and protective device set-points
g. PSS status and set-points
h. Regulator supply breaker status
i. Control power voltage
j. Field voltage and current
k. Regulator supply voltage
l. Field flash status
m. Generator Voltage, Current, kW and kVAR

Diagnostic messages and instructions from the on-line diagnostic shall be displayed on the operation display.

2.4.19.3 Alarm display

If a system alarm occurs, the display shall be immediately overwritten with an English language message(s) of the alarmed conditions. All alarms shall be displayed and retained until the alarmed conditions clears and the alarm indication is reset. The first alarmed condition shall be noted on the display screen. All subsequent alarms shall be retained and displayed. Cleared alarm conditions shall be reset individually. A single operation of the RESET pushbutton shall reset all cleared alarm displays. The following alarm conditions shall be provided as a minimum:

a. AC Regulator Trip
b. Bridge Overtemperature
c. Transformer Overtemperature
d. Regulator Power Supply Single Phase/Phase Balance
e. Potential Transformer Blown Fuse
f. Field Overvoltage
g. Over Excitation Limit
h. Under Excitation Limit
i. PPT Secondary Overcurrent
j. Volts/Hertz
k. Loss of Excitation
l. Power System Stabilizer
m. Fan Failure
n. Control Power Supply Failure

The above alarms shall also be individual inputs to the exciter annunciator.

2.4.19.4 Unit S Board Annunciators

The following alarms shall be provided, hard-wired, for the unit S board annunciators:

a. Exciter Trouble
b. AC Regulator Trip
c. Excitation Upper Limits
d. PSS Failure

The same alarms shall be provided as hard-wired inputs to the powerhouse SCADA system. SCADA alarms will be terminated in the unit S panels. The Contractor will not be responsible for the actual connections to the SCADA equipment.

2.4.20 Indicating Instruments

Electrical dial indicating instruments shall be provided for field amps and field voltage, and shall be mounted on the unit control switchboard S panels. The existing control and indicating lights can be reused. The indicating instruments shall be switchboard type, shall conform to the applicable requirements of ANSI C39.1, and shall have an accuracy rating within 1 percent of full-scale value. The instruments shall be back connected for semiflush mounting. Instruments shall have white

dials, circular scales, black scale markings, and black tapered anti-parallax pointers. Instrument cases shall be dust-tight with shadow proof covers, and antiglare windows. Instruments shall be 4 ¼ inch minimum rectangular type with nominal 250-degree scale angle. Instrument scales shall be appropriate for the application. All indicating instruments, which may be required for local adjustments or test, shall be provided.

2.4.21 Indicating Lights

The existing 125 Vdc indicating lamps on the unit control switchboards shall be reused.

2.4.22 Calibrated Leads

Calibrated leads from the field current shunt in the exciter cubicle to the remote field current ammeters shall be provided.

2.4.23 Exciter Annunciator Equipment

Annunciator equipment consisting of the following equipment, and including any additional equipment required for proper operation, shall be provided and flush mounted in the excitation cubicles:

a. The annunciation equipment shall use solid-state logic units.

b. The annunciation equipment shall be capable of operation from the ungrounded 125-volt dc station battery with supply voltage variations of 103 to 140 volts. The annunciation circuits shall not introduce grounds on the 125-volt dc system.

c. The annunciator shall be design and tested for surge withstand capability in accordance with IEEE C37.90.1.

d. Annunciator indication shall be lighted window or light emitting diode (LED) type. If a lighted window annunciator is provided, each window shall be illuminated individually from the rear. Annunciation windows shall be translucent white with a matte finish and black filled engraving. Window sizes shall be approximately 1 by 3 inches. If a LED indication annunciator is provided, an engraved legend plate shall be provided for each point.

e. A logic unit shall contain pushbuttons for ACKNOWLEDGE, TEST, AND RESET functions. The pushbuttons shall be momentary-contact type with engraved tags.

f. The annunciators shall be capable of operation from external “acknowledge” and “reset” commands.

g. One relay output (reflash) for signaling a remote annunciator shall be provided. All input alarms shall be grouped to operate the reflash contact output.

h. The annunciator equipment shall be designed so that the operation incorporates ISA-S18.1 Sequence M; that is, the closure of a trouble contact shall simultaneously illuminate, with a flashing light, the appropriate annunciator point- indicator regardless of the number

of other points already activated, and shall output a reflash signal to the remote monitoring device. The point-indicators shall not be automatically extinguished by any means, but shall change from flashing to steady light when the annunciator has been acknowledged. They shall remain energized until the trouble contact has opened and the annunciator has been reset.

i. The annunciators shall incorporate, as a minimum, those alarms identified in paragraph 2.4.19.3.

2.4.24 Flat Cable

Flat cable may be used for interconnecting internal logic card racks. However, flat cables shall not be used on output contacts to powerhouse equipment. Flat cables may be the ribbon type or woven type. Flat cable used for low-voltage data buses shall be of the woven twisted-pair type.

2.4.25 Terminal Blocks

Terminal blocks that do not connect to external cables for powerhouse equipment may be the manufacturer's standard type. All other terminal blocks shall be molded or fabricated type with barriers, rated not less than 600 V with 30 A capacity. Short-circuiting-type terminal blocks shall be furnished for all current transformer secondary leads and shall have provisions for short-circuiting together all leads from each current transformer without opening any circuit. The terminals shall be removable binding, fillister, washer-head screw type, or high-density screw type. Each terminal shall have length and space for connecting two No. 10 AWG conductors to each terminal. White or other light colored marking strips shall be provided for circuit designation. Each connected terminal of each block shall have the circuit designation or wire number placed on the marking strip with permanent marking fluid. Two reversible or spare marking strips shall be furnished with each block and at least 10 percent spare terminals shall be provided.

2.4.26 Test Blocks

Test blocks shall be of the back-connected, semiflush mounted, switchboard type with removable covers and shall be provided with knife switches. Test blocks shall be rated not less than 250 volts, 10 amperes, and shall be capable of withstanding a dielectric test of 1,500 volts, 60 Hertz, for one minute. The cases shall be dust tight and shall have a black finish. All test blocks shall be arranged to isolate completely the instruments from the instrument transformers and other external circuits so that no other device will be affected, and means shall be provided for testing either from an external source of energy or from the instrument transformers by means of multiple test plugs. The test blocks and plugs shall be arranged so that the current transformer secondary circuits cannot be open-circuited in any position while the test plugs or cover plugs are in place, being inserted, or being removed.

2.4.27 Test Signal Inputs

Circuitry shall be provided for injecting an arbitrary analog voltage input in the voltage sensing hardware path such that the analog sum of the terminal voltage and the analog input is derived and presented to the digital regulator for testing consistent with IEEE STD 421.2, paragraph 6.3.1. In addition, a manual jog button will be provided that injects a preset step analog signal into the analog sensing circuitry, reference, or summing junction hardware. The size of the jog shall be adjustable from 0 to 15% of the terminal voltage under no load. The analog signal injection circuitry shall interface to the exciter through the test blocks.

2.4.28 Nameplates

2.4.28.1 Device Nameplates

Each item of equipment mounted on the excitation cubicle and on the remote panels shall be provided with an engraved nameplate. Nameplates shall be made of laminated sheet plastic or of anodized aluminum approximately 1/8 inch thick, engraved to provide white letters on a black background. The size of the letters shall be no less than 3/16 inch high. The nameplates shall be fastened to the panels in proper positions with black finished roundhead screws.

2.4.29.2 Equipment Nameplates

The manufacturer shall supply and attach to the excitation cubicle assembly a nameplate and may attach a trademark. Manufacturer nameplate information shall include the following:

a. Manufacturer's name
b. Date of manufacture
c. Serial number
d. Rated voltage
e. Maximum and minimum voltages
f. Rated current
g. Maximum current
h. Regulator characteristics

2.5 EXCITATION SYSTEM PROTECTION

2.5.1 General

The following protective features shall be provided as part of the exciter control system or as relaying mounted separately, as indicated in paragraph 2.4.16.

2.5.2 Overexcitation Limiter

An adjustable overexcitation limiter (OEL) shall be provided to automatically limit the excitation of the generator to a safe value with the excitation under control of the regulator. The OEL shall allow inverse-time overload of the generator field circuit consistent with thermal limitations. The primary control shall limit excitation for field circuit overload after an adjustable time delay, but shall automatically return to normal voltage regulation when the overload is relieved. The limiter shall prevent field winding overheating under conditions of repetitive field forcing. The device shall be provided

with one set of electrically separate contacts, which close when the device is in the limiting mode.

2.5.3 Underexcitation Limiter

An adjustable underexcitation limiter (UEL) shall be provided to automatically limit the decrease of generator excitation below that which may result in pullout of the generator. The characteristics of the minimum excitation limiter shall closely match the manufacturer's capability curves. This minimum excitation limit curve shall be user selectable. The UEL shall be provided with one set of electrically separate contacts, which close when in the limiting mode.

2.5.4 Fault Overcurrent Protection

Three single-phase, very inverse time overcurrent relays, or one three-phase very inverse overcurrent relay in a common housing with independent elements for each phase, shall be provided for excitation transformer overcurrent protection.

2.5.5 Phase Balance

Power potential transformer phase balance current protection, to provide indication of a blown current limiting fuse, thyristor misfire, or single phasing of the power potential transformer, shall be provided.

2.5.6 Field Ground Detector

2.5.6.1 Field Ground Detector Relay

Field ground detection relays shall be provided. These relays shall be suitable for mounting in an approved location in the individual unit control switchboards. The field ground detector shall be suitable for detecting a ground resistance of 5,000 ohms or less. The Contractor shall provide auxiliary relays and wiring necessary to automatically disconnect the relay leads during field flashing to avoid false battery ground indications.

2.5.6.2 Shaft Grounding Brush

In conjunction with the ground detection, a shaft grounding brush shall be provided for mounting by a separate contractor. A support and conductor required to ground the shaft to the plant ground shall be provided. The ground brush shall be located below the generator rotor.

2.5.7 Volts/Hertz Limiter

A volts/hertz limiter shall be provided which is responsive to both varying voltage and varying frequency and shall act through the regulator circuitry to take corrective action to prevent damage due to heating during low-frequency operations. This device shall be provided with one set of electrically separate contacts which close when the device is in the limiting mode.

2.5.8 Volts/Hertz Protection

Volts/hertz protection shall be provided to protect the generator armature and power potential transformer windings from overheating during low-frequency operations. This protection shall be in addition to the volts/hertz limiter and shall be coordinated to operate at a slightly higher volts/hertz level than the volts/hertz limiter. This protection shall be adjustable and operate unit trip contacts from the exciter into Government alarm and shutdown circuits.

2.5.9 Emergency Shutdown

If serious trouble requiring shutdown of the generator and its removal from service should occur, the excitation system shall be capable of being automatically de-energized. This operation shall include interrupting all sources of generator field current and dissipation of the stored energy in the field. Any internal faulted condition of the excitation system that requires immediate shutdown of the exciter shall also operate the exciter unit trip contact to operate the governor shutdown circuits.

2.6 SPECIAL TOOLS

All special wrenches, tools, slings, and other equipment that may be necessary or unique for assembling or dismantling any part of the excitation system and auxiliary equipment, including lifting devices for the excitation supply breaker, shall be supplied. One complete set shall be furnished for each Project for a total of two complete tool sets furnished. All tools and equipment shall become and remain the property of the Government. The wrenches and tools shall be supplied in steel boxes equipped with trays and lids to separate and identify the various items.

2.7 SPARE PARTS

All spare parts furnished shall be interchangeable with and shall be of the same material and workmanship as the corresponding original parts. Spare parts to be furnished for the generator excitation systems shall include the following. One complete set of the following spare parts shall be furnished for each Project for a total of two complete sets furnished.

a. Two complete replacement sets of all main power thyristors and diodes in the excitation system rectifier bridge assembly.

b. One power capacitor of each type, if required.

c. One power transistor of each type, if required.

d. One saturable core reactor of each type, if required.

e. One control transformer, auxiliary power supplies or isolating transformers, auxiliary instruments or coupling transformer, and choke or inductor of each type and rating as applicable.

f. One complete set of operating coils, springs, stationary and moving contact assemblies, and auxiliary contacts as required for each type and size of ac and dc contactor and auxiliary switch as applicable.

g. One complete set of annunciator spares including 1 annunciator power supply, 2 input modules of each type, 1 logic module of each type, and 1 annunciator auxiliary relay of each type.

h. One speed sensor, tachometer set.

i. One power supply of each type.

j. One protective and auxiliary relay of each type.

k. Two complete rectifier assembly cooling fan sets.

l. One rectifier Supply Breaker

m One control switch of each type as applicable.

n. One printed circuit card of each type with components.

o. One printed circuit card receptacle of each type, if required.

p One printed circuit card extender of each type, if required.

q One Power System Stabilizer

r Ten indicating lamps of each type, if applicable.

s. One indicating lamp puller, if applicable.

t. quart containers of finish paint (touch-up) for the exciter and transformer cubicles (outside surfaces).

The Contractor shall complete the Spare Parts Receipt and shall submit a copy of the completed and signed receipt to the Contracting Officer after the spare parts and documentation have been delivered to the Government. Blank copy of spare parts receipt is attached at the end of this section.

2.8 SPECIAL TEST EQUIPMENT

The Contractor shall furnish all test equipment and tools that are required for performing the small signal performance testing of IEEE 421.2, para.7.2, and for performing step and frequency testing of IEEE 421.2. Step test equipment shall allow ± 10 percent, ± 5 percent, and ± 2 percent voltage and/or current input steps at the exciter input terminals. All test equipment shall be new and may be used by the Contractor for performing required field tests. After completion of the work the test equipment and tools shall be put into the original containers and all but the equipment used for frequency response testing shall be turned over to the Government Inspector, and shall remain the property of the Government.

PART 3 EXECUTION

3.1 ARRANGEMENT AND ASSEMBLY

The location and general arrangement of the equipment shall be as shown on the drawings with minor variances for installation and connection to existing installed equipment. Modifications of the equipment arrangement or equipment device requirements shall be subject to approval. The exciter shall be completely assembled, wired, and tested at the factory. The equipment shall be shipped as completely assembled and wired as feasible so as to require a minimum of installation work. Each shipping section of the equipment shall be properly match marked to facilitate assembly and shall be provided with removable lifting channels with eye bolts for attachment of crane slings to facilitate lifting and handling. All hardware and material necessary for assembly shall be furnished. Any relay, indicating instrument, or other device which cannot withstand the hazards of shipment when mounted in place on the equipment, or which are to be mounted in a separate location, shall be carefully packed and shipped separately. These pieces shall be marked with the number of the panel on which they are to be mounted and fully identified so they can be readily mounted and connected. All finished painted surfaces and metal work shall be wrapped suitably or otherwise protected from damage during shipment. Major components in the excitation cubicles shall be identified with painted letters or numbers or suitable labels, corresponding to the identifications shown on approved shop drawings. The Contractor shall furnish all labor, tools, equipment, and materials needed for removal of the existing equipment and installation of the excitation system. Unless otherwise specified or directed, all excitation system installation and erection procedures shall be in accordance with those outlined in IEEE 1095.

3.2 INTERNAL WIRING

All enclosures and devices shall be completely wired to designated terminal blocks for connection to external devices. The Contractor’s standard cables and methods of cable terminations may be used between standard modules within the cubicles. Wiring, where not installed in channels or ducts, shall be formed into compact wire bundles suitable bound together and properly supported. No splices shall be permitted in any of the wiring. Hinge wire shall be used between stationary panels and swinging doors and shall be formed in wire loops, which will Provide rotation around the longitudinal axis of the conductors. Hinge wire shall be Class K stranding. Any wiring extending beyond the equipment cubicles shall be terminated at 600 V terminal blocks except excitation system power leads such as generator field leads, shunt leads, etc. Special attention shall be given to terminal wiring arrangements on the terminal blocks to permit individual conductors of each external cable to be terminated on adjacent terminal points. The wire (terminal point) designations used on the Contractor’s wiring diagrams may be according to the Contractor’s standard practice; however, additional wire and cable designations for identifications of external circuits may be requires. Prints of wiring and terminal drawings submitted for approval will be marked and returned to the Contractor for addition of the Government’s designations to the terminal strips, along with any rearrangement of points required.

3.3 FACTORY ASSEMBLY

Complete assembly of the excitation cubicle, the high-voltage fuse cabinets, and the power potential transformer cubicle are required.

The exciter system shall be completely assembled at the factory before testing.

3.4 FACTORY TESTS

3.4.1 General

Factory tests on the excitation system shall be made in accordance with applicable requirements of ANSI C34.2, except as herein definitely stated, and the Contractor's approved procedure. All tests required herein shall be witnessed by the Government Quality Assurance Representative (GQAR), unless waived in writing, and no equipment shall be shipped until it has been approved for shipment. The GQAR shall be given notification of factory tests two weeks before they are to be performed. The waiver of any tests, or the witnessing thereof by the GQAR, shall not relieve the Contractor of the responsibility of meeting the requirements of these specifications. All test equipment, instruments, and personnel, shall be furnished by the Contractor. The cost of performing the routine tests shall be included in the prices bid in the schedule for the equipment. The cost of performing the Special Tests shall be included in the bid schedule under the bid item for "Perform Special Factory Test".

3.4.2 Routine Tests

Each excitation system shall be subjected to routine tests, including but not restricted to the following:

a. Dielectric tests in accordance with ANSI C34.2.

b. Rated voltage tests.

c. Functional sequencing check of circuit components for proper operation.

d. Tests of excitation system power potential transformer in accordance with IEEE C57.12.91.

e. Surge withstand test in accordance with IEEE C37.90.1. If the type of exciter being provided has passed the surge tests, documentation of the test may be provided en lieu of performing the test again.

f. High Potential Tests in accordance with IEEE 421.3.

3.4.3 Special Factory Tests

The Contractor shall perform the following special factory tests on the excitation system for one of each type provided. At the Contractor's option, test items "d" and "e", listed below, may be performed as field tests, and shall conform to the requirements of paragraph 3.5.

a. Rated current test. Subject to approval, a test at 110 percent rated current and reduced voltage as outlined in ANSI C34.2 may be substituted.

b. Heat run to determine maximum temperature rise. This test shall include a heat run at exciter rated output. Subject to the approval of the Contracting Officer a heat run at 110 percent rated current and reduced voltage as outlined in ANSI C34.2 may be substituted in lieu of the heat run at rated output.

c. Phase control range.

d. Tests to determine the transient performance. These tests shall include determination of the excitation system voltage response time and excitation system ceiling voltage. Excitation system voltage response time and excitation system ceiling voltage shall be determined with the excitation system at rated load field voltage and loaded with a resistance equal to generator field resistance at 75 °C. The voltage response time and ceiling voltage shall be determined as outlined in IEEE 421.2, Section 3.

e. Test to demonstrate performance at extremes of input voltage to the exciter.

f. Reserved.

g. Excitation system short-time overload capability.

h. Excitation system rectifier assembly current unbalance. The maximum unbalance of currents in the parallel paths of the rectifier assembly shall not exceed ± 10 percent.

i. Verify that all functional and operational performance requirements of the PSS, as outlined in paragraph 2.4.7, including integration of the requirement for two sets of parameters described in paragraph 2.4.6.8.

j. All other electrical parts, such as voltage adjusters and similar devices, shall be tested individually in accordance with industry standards. Where parts are in quantity production and routine tests are made and such routine tests are in accordance with the industry standards, individual tests of such parts will not be required. However, in either event, certified test data covering each part shall be submitted.

3.5 SPECIAL FIELD TESTS

3.5.1 General

One excitation system of each type provided shall be field tested by and at the expense of the Contractor to determine whether the contractor’s guarantees and the requirements of these specifications have been fulfilled. The tests shall be made in accordance with the applicable requirements of ANSI C50.10, ANSI C50.12, and IEEE 115, except as herein definitely stated. All test equipment, including their calibration, equipment instrument transformers, temporary installations and personnel, shall be furnished by the Contractor. Test procedure outlines shall include a list of instruments and equipment to be used and wiring diagrams showing all temporary connections to the existing powerhouse equipment.

3.5.2 Operational Tests

The entire excitation system shall be subjected to operational tests and adjustment to show compliance with all performance requirements of these specifications. The following additional special field tests shall be made on the excitation system for one generator of each type provided.

3.5.2.1 Test for Wave Form Deviation Factor

Oscillograms shall be taken of the wave form of the voltage of each phase of the stator winding when the generator is operating at rated voltage and frequency at no load.

3.5.2.2 Tests for Excitation System Performance

These tests shall consist of taking oscillograms of the generator voltage variations as step errors of up to 5 percent are introduced into the regulator sensing circuit under the following conditions:

a. Rated load, without PSS

b. Rated load, with PSS

c. Open-circuited, without PSS

d. Open-circuited, with PSS

e. As loads of up to 100 percent of rated load at rated power factor are rejected at the machine terminals.

Under loaded conditions, the terminal voltage overshoot shall not exceed 5 percent. Open-circuited, the terminal voltage overshoot shall not exceed 15 percent. Response shall be damped.

3.5.2.3 Efficiency Tests

These tests shall include the determination of the excitation system losses. Losses measured shall include as applicable, those losses listed in paragraph 5.3.5.2 of ANSI C34.2. Excitation losses shall also include the calculated I^2R losses in the dc bus from the excitation cubicle to the generator collector rings and the total power supplied to the excitation system auxiliaries when in service under steady-state conditions.

3.5.2.4 Underexcitation Limiter Tests

The underexcitation limiter shall be tested by operating the generator at various real power settings and decreasing the excitation until the limiter operates. Record a table of real and reactive power levels, terminal voltage, and field current, and construct a graph of the operating points.

3.5.2.5 Overexcitation Limiter Tests.

The overexcitation limiters (OEL) may be tested at a reduced level, then returned to their proper settings. The timed OEL shall be tested by placing a large step into the voltage regulator and observing the excitation levels. The inverse-time curve of the OEL shall be verified by testing the instantaneous limiter at several values and timing the return to the OEL setting.

3.5.2.6 Frequency Response Test.

Perform a test of overall frequency response of the voltage regulating control system, with the unit on line and the PSS off line, to verify the on-line regulator performance. Quantities measured shall include field voltage and current, PSS output, terminal voltage, and terminal real and reactive power.

3.5.2.7 Small Signal Performance Testing

The contractor shall use an external analog step change signal to demonstrate compliance with paragraph 7.1 and 7.2 of IEEE 421.2.

3.6 EQUIPMENT FIELD INSTALLATION

3.6.1 Equipment Removal

3.6.1.1 General

The work included under this section consists of the removal of the existing non-rotating excitation system equipment, which shall be accomplished in accordance with the Contractor’s approved excitation equipment removal procedure. To the maximum extent practicable, it shall not disturb the integrity of the existing shaft and bearings.

3.6.1.2 Equipment To Be Removed

Existing cables, which serve equipment to be removed shall be disconnected at both ends and shall be completely removed. Exposed conduit which is part of the existing excitation system and which will not be used for the excitation system shall be removed entirely or removed to the embedded part, as applicable. Ends of abandoned embedded conduit shall be plugged flush at the concrete surface with a suitable conduit fitting. The following existing equipment shall be removed:

a. Excitation cubicles.

b. M/G sets.

c. All abandoned and unused power, control, and instrument cables and conduit.

3.6.1.3 Disposition of Removed Equipment.

The Power System Stabilizers, amplifiers, and associated circuitry removed from the units shall remain the property of the Government. The PSS’s shall be carefully removed, cleaned, and stored onsite at a location directed by the Contracting Officer. All other materials that are removed and not reinstalled shall become the property of the

Contractor, removed form the project site, and shall be properly disposed of in accordance with applicable State and Federal laws. Materials that cannot be removed daily shall be temporarily stored in areas approved by the Contracting Officer.

3.6.2 Equipment Installation

3.6.2.2 General

The contractor shall furnish all necessary cable, conduit, fittings, and miscellaneous materials for all power and control connections between the new excitation equipment and Government control and power boards. The excitation system shall be installed, by the contractor, complete and ready for commercial operation of the generator. The equipment shall be installed in the locations shown on the contract drawings. Any changes in the locations shown on the contract drawings shall be approved by the Contracting Officer and shall be shown on the shop drawings of the equipment submitted for approval. Wrenches, tools, and special equipment supplied by the excitation system manufacture for equipment installation, which are damaged during erection shall be replaced at no additional cost to the Government.

3.6.2.3 Equipment to Be Installed

Based on the installation instructions, the specifications and the contract drawings, the Contractor shall install, connect with all control and power wiring, and make ready for field testing the following equipment:

a. Synchronous machine voltage regulator and excitation system, including voltage and current devices, and circuit breakers.

b. Power potential transformer, complete with primary voltage and secondary voltage buses and current limiting fuses.

c. New nameplates, where required, on reused external control, annunciation, and protection devices which provide remote control and monitoring of the new excitation system.

d. Ac and dc cables and conduit, or bus, connecting PPT to generator terminals and to exciter cubicle and connecting exciter cubicle to collector ring brush assembly.

e. Field flashing source equipment.

f. Software on the operator machine interface and the exciter diagnostics workstation Government-provided hardware.

h. New exciter field voltage and current meters and exciter control switch on the unit switchboard S panels.

3.6.2.4 Control Board Modifications

Modifications to existing control boards necessary for interface of the excitation equipment shall be made in accordance with the Government-provided control drawings and approved installation instructions. The Government will furnish the control drawings to the Contractor after

award of contract.

Field Flashing Source

3.6.2.4.1 Circuit Breaker

A new circuit breaker shall be installed in the existing DC panel on unit switchboard. After installation has been completed, the following tests shall be made in the presence of the GQAR.

a. Electrical Operation Test

b. Mechanical Operation Test

3.6.3 Wiring, Cables, and Terminations

3.6.3.2 General

Leads for control wiring within the generator air housing shall be furnished and installed in rigid galvanized steel conduits, where practicable, unless specified otherwise, herein. Calibrated shunt leads for the remote generator field ammeter shall be installed by the Contractor. Conduits shall be arranged, as far as practicable, to make removal unnecessary when the generator is dismantled. All leads from the excitation cubicle to the generator switchboard shall be furnished and installed as part of the excitation system installation.

3.6.3.2 Installation

All wire and cable shall be installed in accordance with NFPA 70 requirements. All necessary materials, tools, and equipment required for proper handling and installation of wire and cable in conduits, cable trays, and elsewhere shall be furnished. Except for spares, each wire and cable shall be connected to the associated equipment at both ends and shall be continuous and without splices between the equipment termination points. Wire and cable shall be pulled in a manner that will preclude damage to the conductor, insulation, or jacket. Any cable damage during installation shall be removed and replaced. Installation of wire and cable shall include installation of all supporting devices and all terminations required to complete the circuits as required. Wire and cable shall not be pulled into conduit runs until the conduit has been checked and determined to be clean and dry by pulling a clean, dry, tight-fitting rag through each run. Only approved lubricants may be used to facilitate pulling of conductors. Cable trays shall be cleaned of all dirt and trash before pulling conductors. Cable trays shall be cleaned of all dirt and trash before pulling cable. Cables shall be placed straight and parallel in the trays.

3.6.3.3 Equipment Wiring

Cables and wires entering switchboards, exciter cubicles, cabinets, and similar equipment will require routing within the equipment to the applicable terminal blocks. Where not installed in wiring channels and ducts, cables and wires shall be formed into compact groups suitably bound together and properly supported.

3.6.3.4 Terminations

All cable and wire connections shall be made at terminal blocks except, if applicable, for the power potential transformer high-voltage and low-voltage cable buses. Shielded power conductors shall be terminated with stress cones with the shielding grounded at each stress cone. Unshielded conductors for circuits above 1,000 V shall be terminated with a corona preventive tape. The shield and shield-insulating jacket of shielded signal cables and conductors shall be maintained to a point as close to the terminals as possible. The shield-insulating jacket shall not be stripped form the shield except where necessary to make the ground connection. All signal cable shields shall be grounded at one end only.

3.6.3.5 Identification

All multiple-conductor cables shall be clearly identified with the cable designation by either embossed 1-inch diameter brass tags or by embossed aluminum band markers. Tags or band markers shall be securely fastened to the cables at each termination, junction, or pull box where cables enter or leave cable trays and as required at other points of access. Wires and individual conductors of control and power cables shall be identified with nonmetallic tube-type markers at each termination. Wire markers shall be heat shrink tube type, machine printed and shall be suitable for contact with rubber or neoprene or plastic. Tubing shall be sized to fit the wire being marked and shall have black marking on a light colored background. Installed markers shall be uniform in position on the wire and legends shall be visible when wires are terminated on terminal blocks or equipment. A written certificate from an approved independent testing laboratory shall be furnished to indicate that the markers will not stain or discolor after 20 years service when subjected to an accelerated aging test while in contact with wire insulating materials. Identification on tags and markers shall be as shown on the drawings or as directed. The Government will provide marked drawings to the Contractor before the installation of the first excitation system.

3.6.3.6 Installation Tests

After installation, but just prior to terminal connection, each conductor shall be tested as follows:

a. A 1,000 V “Megger” test shall be performed with all other conductors in each cable or conduit grounded. The final insulation resistance of each conductor shall not be less than 1 megohm.

b. A continuity test of each conductor from terminal to terminal shall be performed.

c. Records shall be kept of all tests, indicating the “Megger” readings, high-voltage tests, continuity test, and conductor identification markings. Prior to testing, the test record form shall have been submitted and approved.

d. Any length of wire or cable failing under these tests shall be replaced at no additional cost to the Government.

e. The Contractor shall furnish all instruments and personnel for these tests.

f. Tests shall be witnessed by the GQAR and the test form shall provide room for his signature.

3.6.4 Conduits, Fittings, and Accessories

Conduit to be installed under this contract shall be run exposed for connecting circuits between items of equipment. Conduit, fittings, and accessories shall be installed in accordance with details shown on the drawings and as specified herein. All conduit shall be Rigid Metal Conduit (RMC) only.

a. All conduit bends shall have a radius of not less than 10 times the inside diameter of the conduit.

b. No threadless fittings or running-thread couplings shall be used on conduit runs.

c. Metal conduits shall be cut only with a tool approved for the purpose. All cuts shall be square and the conduit opening shall not be constricted. After cutting and threading, conduit ends shall be reamed to remove rough edges and burrs, and the entire conduit shall be thoroughly cleaned to remove all cuttings, dirt, and oil form its interior. Threads shall be clean cut. Threaded joints in metal conduit and terminations in cast boxes shall have the threads coated with an approved joint compound, and shall be screwed tight to make the joint watertight and to provide electrical continuity of a give conduit system. Suitable watertight conduit hubs and bushings shall be provided where conduit terminates within a box, terminal cabinet, or accessory that has no threaded hub or fitting to receive threaded conduit.

d. All conduits shall be installed in a manner to ensure against trouble from the collection of trapped condensation, and all runs shall be arranged to avoid traps wherever possible.

e. Pull boxes shall be furnished and installed, complete with covers, in conduit runs as required by NFPA 70 and good practice in the trade, regardless of whether the boxes are specified on the drawings.

f. Conduit shall be installed with a minimum of bending and cutting. Conduits not dimensioned as to location shall be installed approximately where shown on the drawings with limited adjustment to avoid interference with other work. Conduit shall be rigidly attached with approved supports and anchors to the surface over which it is run. The maximum spacing of supports for the exposed conduit shall be 8 feet. Supports for exposed conduit on concrete surfaces shall be fastened securely to the concrete with approved anchors. Wooden, fibrous, or similar plugs inserted into the concrete will not be accepted.

g. The entire metallic conduit system installed in the powerhouse by the excitation system contractor shall be electrically continuous and thoroughly grounded. No welding or brazing of the grounding conductor to the conduit will be allowed. All grounding connections to

the conduit shall be made by means of listed grounding bushings or by an approved pressure type connector.

3.7 CONTRACTOR'S WORK SUPERVISORS

At least one full-time employee of the Contractor shall be available at each worksite anytime contract work is performed on site to supervise and direct the work. Supervisors shall be present at the sites during disassembly and installation and shall be responsible for providing complete and correct direction of all disassembly and installation work, commissioning, and field testing. The supervisors shall initiate instructions for all actions necessary for the proper inspection, handling, assembly and testing of the equipment. The supervisors shall keep a record of all measurements taken during installation and shall provide copies on request or on completion of installation of each unit. The supervisors shall keep all as-built drawings current and provide copies or the final as-built (final drawings) upon completion of the work. The supervisors shall be fluent in the spoken and written English language. The supervisor shall have been engaged in similar excitation installation work, as is specified herein for a minimum of 3 years, and shall have performed this work at a minimum of two different powerhouses and on at least two hydraulic generating units. The Supervisors qualifications, experience, a verifying contact, name and phone number, shall be submitted for at least two such facilities.

3.8 CONTRACTOR-FURNISHED TRAINING

No later than 30 days prior to the first excitation system being placed in service at each Project, an initial training session shall be conducted in the theory, operation, and maintenance of the generator excitation system. The course shall be of 40 hours minimum duration Monday through Thursday (4 days at 10 hours per day) for approximately ten Government personnel at each of the two projects. The course shall include excitation system design, theory of basic circuits, trouble-shooting of printed circuit cards, and excitation system trouble analysis. Course material shall include the use of site-specific Operations and Maintenance Manuals, to the maximum extent possible. The number of copies of O&M manuals required for the initial training is in addition to the number of copies of O&M manuals required in paragraph 1.10, Section 01330. Training shall not begin until approved Operation and maintenance Manuals are available for use during the training session. After the O&M manuals are completed, approved, bound, and available for use and at least 3 weeks prior to the beginning of the training, the Contractor shall submit a synopsis of the training and curriculum. The course shall include in depth hands-on training for each student on the setup, displays, and excitation parameter changing on the operator-exciter interface panel. Additionally, a separate minimum eight hour course (3 sessions 8 hours each session shall be conducted which covers operation only. The operations course shall be provided for three different groups of operations personnel at each project site. The three operator sessions shall be scheduled one week apart from each other to maximize government benefit as operators work rotating shift work with only one operator at any one time. The Government may videotape the training sessions for future use by the Government. Within ten calendar days following installation of the three exciters at each Project, a follow-up training session shall be conducted covering the operation and

maintenance of the equipment to allow the Project personnel to ask experienced questions. This course shall be of 20 hours minimum duration (2 days at 10 hours per day) for approximately 10 Government personnel at each project. Course material shall include the use of final approved copies of Operations and Maintenance Manuals. The number of copies of O&M manuals required for the follow-up training is in addition to the number of copies of O&M manuals required in paragraph 1.10, Section 01330. All training shall be conducted during project maintenance crews work days which are Mondays through Thursdays as specified in Section 01010, paragraph 11.2.

3.9 SERVICES OF A SKILLED CRAFTSMAN

Services of a skilled craftsman will be required if the Government discovers work at either of the two Projects that is within the scope of the contract and must be performed but is not included in the drawings and specifications and is not included in any change orders. The additional work could consist of electrical work, mechanical work, metalwork machining, drilling, cutting, grinding, or welding metalwork, or similar work. The Contractor shall furnish all tools and equipment as incidental items for all skilled craftsman work. The Contractor shall perform this work only when directed, in writing by the Contracting Officer. Prices for skilled craftsman hours included in applicable items in the schedule are the prices to be paid only for this additional directed work and these prices shall not be used when negotiating change orders.

3.10 CONTRACTOR QUALITY CONTROL

The Contractor shall establish and maintain quality control as required in Section 01451 to insure compliance with contract requirements and maintain records of his quality control as required in paragraph DOCUMENTATION in SECTION 01451 for all operations. Copies in duplicate of these records and tests, as well as the records of corrective action taken when results are unsatisfactory, shall be furnished to the Contracting Officer within 24 hours following the inspection or test.

3.11 SERVICES OF COMMISSIONING ENGINEER

3.11.1 General

The Contractor shall furnish the services of a Commissioning Engineer. The commissioning engineer shall have a minimum of 5 years experience in the startup of excitation systems and the commissioning of generators.

3.11.2 Duties

The commissioning engineer shall give and be responsible for giving complete and correct direction during the initial starting and all subsequent operation of the equipment until the testing and commissioning of all excitation systems is completed. Additionally, the commissioning engineer shall assist Government personnel and a separate Government contractor by entering voltage regulator and power system stabilizer equipment parameter settings, test the equipment with the settings, and provide test results. The parameter settings will be given to the commissioning engineer by the separate contractor. This will require the commissioning engineer and the separate contractor to be at the project site at the same time. Advanced coordination between the commissioning engineer and the separate contractor for each time they will jointly be on-site must be done through the Contracting Officer. After the Contracting Officer and the Contractor have established a date for performing on-site work, the commissioning engineer shall report to the applicable project site for the agreed to time period.

3.12 ROUTING OF DC BUS

The Contractor shall make an opening in the generator concrete air housing at both the Lower Granite and Lower Monumental Powerhouse generators for routing of the dc bus below the generator deck plates to the brush riggings. Reference Section 03600 for concrete work. Means shall be provided in the dc bus for generator rotor removal. The Contractor shall provide a design showing the bus routing including a detailed electrical design. The design for the penetration through the concrete generator air housing shall be stamped by a registered professional structural engineer and submitted for approval including calculations, details, procedures, and materials.

4. SUMMARY OF SUBMITTALS.

Submittal Register ENG Form 4288 to be furnished by the Contractor shall include the following:

Paragraph	Item	SD	AEA
16251-1.3.1.1	Equipment manufacturers and performance capacities	01	HDC
16251-1.3.1.2	Nameplate schedule	01	HDC
16251-1.3.1.3	Parts list	01	HDC
16251-1.3.1.4	Spare parts list	01	HDC
16251-1.3.1.5	Excitation equipment math models	01	HDC
16251-1.3.2.1	Outline drawings	04	HDC
16251-1.3.2.2	Arrangement drawings	04	HDC
16251-1.3.2.3	Overall one line diagram	04	HDC
16251-1.3.2.4	Schematic diagrams	04	HDC
16251-1.3.2.5	Wiring diagrams	04	HDC
16251-1.3.2.6	Bus connection between power potential transformer and excitation cubicle	04	HDC
16251-1.3.2.7	Generator bus tap design	04	HDC
16251-1.3.2.8	Design of dc circuit to slip rings	04	HDC
16251-1.3.2.9	Equipment installation drawings	04	HDC
16251-1.3.2.10	Circuit card schematics	04	HDC
16251-1.3.2.11	Other drawings	04	HDC
16251-1.3.2.12	As-built drawings	04	HDC
16251-1.3.3.1	Installation plan and schedule	07	HDC
16251-1.3.4.1	Equipment removal procedure	08	HDC
16251-1.3.4.2	Installation procedure	08	HDC
16251-1.3.4.3	Factory test procedure	08	HDC
16251-1.3.4.4	Field test procedure	08	HDC
16251-1.3.4.5	Contractor furnished training	08	HDC
16251-1.3.4.6	Contractors work supervisors	08	HDC
16251-1.3.5.1	Materials	09	C
16251-1.3.5.2	Factory tests	09	HDC
16251-1.3.5.3	Field tests	09	HDC
16251-1.3.6	Operation and maintenance manuals	19	HDC
16251-3.12	Design for routing of dc bus	01/04	HDC

Code for Submittal Description (SD)	
01	Data
04	Drawings
06	Instructions
07	Schedules and Plans
08	Statements
09	Reports
13	Certificates
14	Samples
18	Records
19	O & M Manuals

Action Element for Approval (AEA)	
C	Contractor
AE	Architect Engineer
ED	Engineering Division
CD	Construction Division
EDA	Engineering Division, Architectural Design
EDC	Engineering Division, Soils/Civil Design
EDE	Engineering Division, Electrical Design
EDG	Engineering Division, Geology & Dam Safety
EDH	Engineering Division, Hydraulic Design
EDM	Engineering Division, Mechanical Design
EDS	Engineering Division, Structural Design
EDSP	Engineering Division, Specifications
ECC	Environmental Compliance Coordinator
HDC	Hydroelectric Design Center

(Spare Parts Receipts 2 pages and
Saturation Test Curves 2 pages follow)

* * * * *

SPARE PARTS RECEIPT
LOWER GRANITE DAM

Contract No.: _____

Contract Name: _____

Contractors Name: _____

Technical Specification Number: 16251

Paragraph Number: 2.7

List of Spare Parts Delivered (Quantity and Description): *

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

All spare parts required in the technical specification section are included: Yes □ No □

All documentation required in the technical specification is complete and included: Yes □ No □

VERIFICATION: The above spare parts receipt is complete and correct, all required spare parts have been turned over to the Government, and all documentation is complete and included with the spare parts.

_____ _____
Contractor's Representative Date

_____ _____
Government's Representative Date

*Attach additional sheets as necessary.

SPARE PARTS RECEIPT
LOWER MONUMENTAL DAM

Contract No.: _____

Contract Name: _____

Contractors Name: _____

Technical Specification Number: 16251

Paragraph Number: 2.7

List of Spare Parts Delivered (Quantity and Description): *

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

All spare parts required in the technical specification section are included: Yes □ No □

All documentation required in the technical specification is complete and included: Yes □ No □

VERIFICATION: The above spare parts receipt is complete and correct, all required spare parts have been turned over to the Government, and all documentation is complete and included with the spare parts.

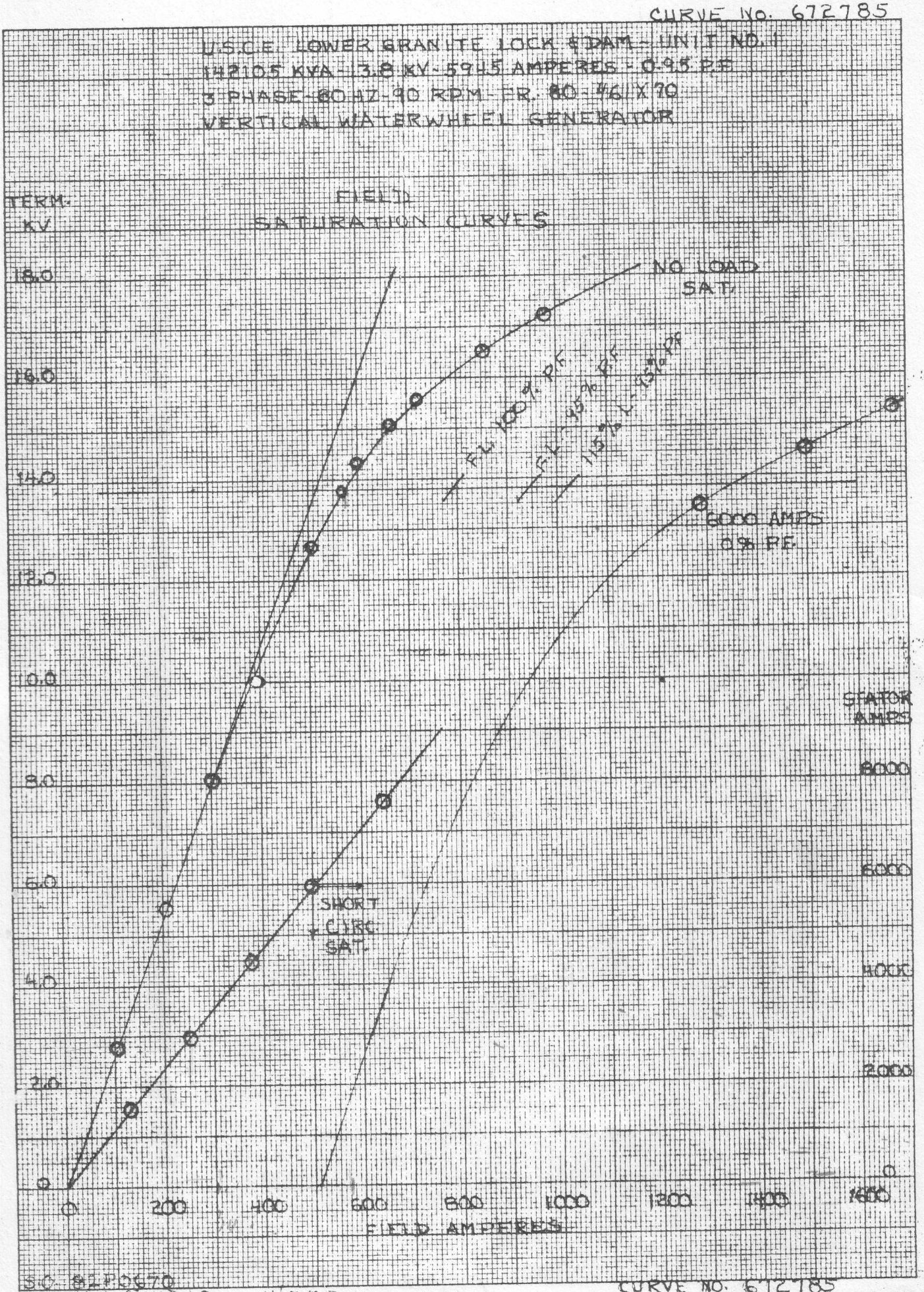
_____ _____
Contractor's Representative Date

_____ _____
Government's Representative Date

*Attach additional sheets as necessary.

CURVE NO. 672785

U.S.C.E. LOWER GRANITE LOCK & DAM - UNIT NO. 1
142105 KVA - 13.8 KV - 5945 AMPERES - 0.95 P.F.
3 PHASE - 60 HZ - 90 RPM - FR. 80 - 46 X 70
VERTICAL WATERWHEEL GENERATOR



S.O. 82P0670
W. EGIDIO 11/5/75

CURVE NO. 672785

10 X 10 TO THE CM. 359-14
KEUFFEL & ESSER CO MADE IN U.S.A.

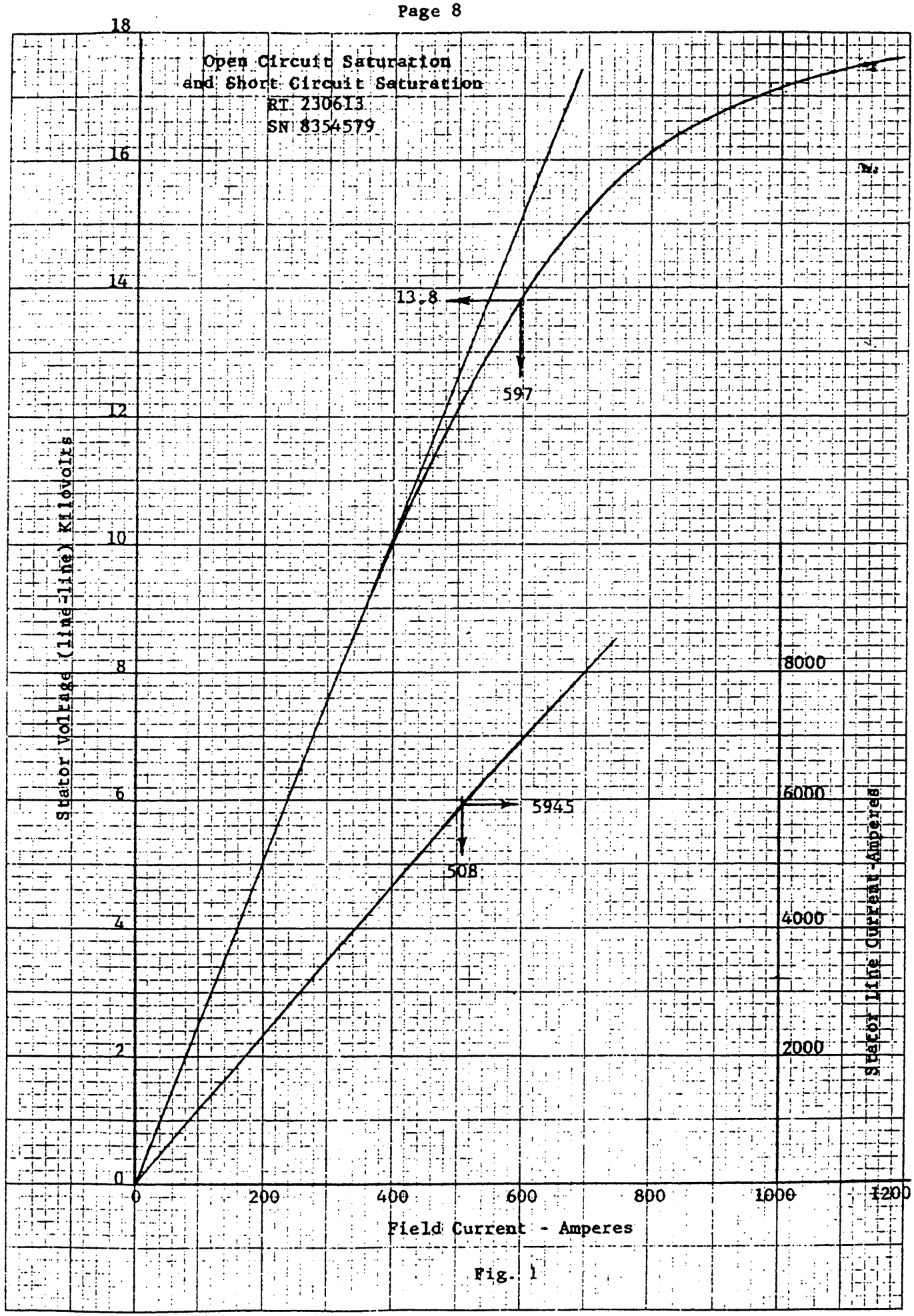

Open Circuit Saturation
and Short Circuit Saturation
RT 230613
SN 8354579
Stator Voltage (line-line) Kilovolts
Stator Line Current-Amperes
Field Current - Amperes
13.8
597
5945
508
0
2
4
6
8
10
12
14
16
18
2000
4000
6000
8000
0
200
400
600
800
1000
1200

Fig. 1

SECTION H Special Contract Requirements

Revised Drawing List. Two revised drawings and two new drawings added

252.236-7001 CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS
(AUG 2000).

(a) The Government will provide to the Contractor, without charge, one set of contract drawings and specifications, except publications incorporated into the technical specifications by references, in electronic or paper media as chosen by the Contracting Officer.

(b) The Contractor shall--

(1) Check all drawings furnished immediately upon receipt;

(2) Compare all drawings and verify the figures before laying out the work;

(3) Promptly notify the Contracting officer of any discrepancies;

(4) Be responsible for any errors which might have been avoided by complying with this paragraph (b); and

(5) Reproduce and print contract drawings and specifications as needed.

(c) In general --

(1) Large-scale drawings shall govern small scale drawings; and

(2) The Contractor shall follow figures marked on drawings in preference to scale measurements.

(d) Omissions from the drawings or specifications or the mis-description of details of work that are manifestly necessary to carry out the intent of the drawings and specifications, or that are customarily performed, shall not relieve the Contractor from performing such omitted or mis-described details of the work. The Contractor shall perform such details as if fully and correctly set forth and described in the drawings and specifications.

(e) The work shall conform to the specifications and the contract drawings identified on the following index of drawings.

FILE NUMBER	SHEET NUMBER	TITLE	REVISION NUMBER	DATE
LMG-1-0-1/193	0	**LOWER MONUMENTAL LOCK AND DAM LOWER GRANITE LOCK AND DAM UNITS 1-3 EXCITER REPLACEMENT**		
		LOWER MONUMENTAL - UNITS 1-3 EXCITATION REPLACEMENT		
LMP-5.8-0-0A0/1	0	PROJECT LOCATION VICINITY MAP, AND DRAWING INDEX	2	5-20-04

LMP-5.8-6-1E11/1A	1	MAIN UNIT BAYS – EQUIPMENT REMOVAL		
LMP-5.8-6-1E11/1B	2	MAIN UNIT BAYS – EL. 444.0		
LMP-5.8-6-1E11/2	3	SECTIONS & DETAILS		
LMP-5.8-6-9A24/1	4	EXCITATION SYSTEM EXTERNAL CONNECTIONS		
LMP-5.8-6-9A24/2	5	EXCITATION SYSTEM BLOCK DIAGRAM		
LMP-5.8-6-9A53/1	6	CABLE REMOVAL SCHEDULE, SHEET 1		
LMP-5.8-6-9A53/2	7	CABLE REMOVAL SCHEDULE, SHEET 2		
LMP-5.8-6-9A53/3	8	CABLE INSTALLATION SCHEDULE, SHEET 1		
LMP-5.8-6-9A53/4	9	CABLE INSTALLATION SCHEDULE, SHEET 2		
		FOR INFORMATION ONLY		
		GOVERNMENT REFERENCE DRAWINGS		
LMP-1.1-6-1E11/1	10	TYPICAL MAIN UNIT BAYS – EL. 444.0		
LMP-1.1-6-1E11/7	11	MAIN UNIT BAYS SECTIONS & DETAILS – SHEET 1		
LMP-1.1-6-9E4/1	12	GENERATOR SWITCHBOARD S1-S3		
LMP-1.1-6-9E21/1	13	UNIT ONE LINE DIAGRAM		
LMP-1.1-6-9E24/1	14	MAIN UNIT CONTROL SCHEMATIC DIAGRAM – SHEET 1		
LMP-1.1-6-9E24/2	15	MAIN UNIT CONTROL SCHEMATIC DIAGRAM – SHEET 2		
LMP-1.1-6-9E24/3	16	VOLTAGE REGULATOR SCHEMATIC		
LMP-1.1-6-9E26/1	17	MAIN UNITS FUNCTIONAL SCHEMATIC DIAGRAM		
LMP-1.1-6-9E51/4	18	UNITS 1-3 VOLTAGE REGULATOR TERMINAL CONNECTIONS		

		GENERAL ELECTRIC REFERENCE DRAWINGS		
44C320761	19	OUTLINE (EXCITATION SWITCHGEAR)		
44D207973 - SHT 3A	20	EXCITATION CUBICLE		
757E650	21	ASSEMBLY HYDRAULIC TURBINE DRIVEN GENERATOR		
		LOWER GRANITE - UNITS 1-3 EXCITATION REPLACEMENT		
GDP-5.17-0-0A0/1	0	PROJECT LOCATION VICINITY MAP, AND DRAWING INDEX	2	5-20-04
GDP-5.17-6-1E11/1A	1	MAIN UNIT BAYS – EQUIPMENT REMOVAL		
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GDP-5.17-6-1E11/2	3	SECTION & DETAILS		
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1116F79	23	VERTICAL HYDRO GENERATOR EXCITER ASSEMBLY		
1094F13	24	GENERAL ASSEMBLY, ITEM & DESCRIPTION LIST		

(End of drawing list)

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(End of Clause)